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April 1976

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    routines for numerical integration
    of kinetic expressions, 75:855
SCHULER, V.J., Experimental studies in
    guiding marine fishes of Southern
    California with screens and
    louvers, 75:984
SCOTT, C.D., See JELLEY, R.L., 75:847
SCOTTI, L.J., See HAMBRAP, J.A.,
    75:705
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Subjects

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

Examples:

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COAL/PURIFICATION
  Application for the benefaction of coal utilizing
    high volatile liquids as chemical comminutants
    (Use of liquid anhydrous NH3 at -33°C to reduce
    size of coal particles), 75:702
COAL GASIFICATION
    See also COED PROCESS
             SYNTHANE PROCESS
COAL GASIFICATION/BI-GAS PROCESS
  Environmental aspects of the BI-GAS process
    (Reactive components in coal are completely
    used in process, and ash for disposal is in
    form of granular, vitreous slag), 75:715 (EPA-
    650/2-74-118)
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Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

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00821    (TE--4190-57-75)  ADVANCED THERMIONIC
  TECHNOLOGY, FY1975.  PROGRESS REPORT NUMBER 4,
  OCTOBER 1974.  (Thermo Electron Corp.,
  Waltham, Mass. (USA)).  1975.  Contract AT(11-
  1)-3056.  18p.  Dep. NTIS $4.00.
```

is indexed as:

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TEXAS INSTRUMENTS, INC., DALLAS (USA)
  Development of low-cost thin-film polycrystalline silicon
    solar cells for terrestrial applications. Third quarter
    progress report, July 1, 1974--September 30, 1974,
    75:00744 (NSF-RA/N--74-144)
TEXTRON, INC., SYLMAR, CALIF. (USA). SPECTROLAB DIV.
  Terrestrial photovoltaic power systems with sunlight
    concentration. Quarterly porgress report, July 1,
    1974--September 30, 1974, 75:00737 (NSF-RA/N--74-129)
THERMO ELECTRON CORP., WALTHAM, MASS. (USA)
  Advanced thermionic technology, FY1975. Progress report
    number 4, October 1974, 75:00821 (TE--4190-57-75)
TYCO LABS., INC., WALTHAM, MASS. (USA)
  Continuous silicon solar cells. Third quarter progress
    report, July 1, 1974--September 30, 1974, 75:00742
    (NSF-RA/N--74-139)
  Scale-up of program on continuous silicon solar cells.
    Semiannual progress report, May 1, 1974--June 30, 1974,
    75:00735 (NSF-RA/N--74-089)
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Volume 1, Number 4, April 1976

ERDA ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

4486 (FE—1752-9) **Research study of issues relative to the development and commercialization of a coal-derived synthetic liquids industry. Quarterly report, July 1975—September 1975.** Candela, B.J. (Hudson Inst., Inc., Croton-on-Hudson, N.Y. (USA)). Nov 1975. Contract E(49-18)-1752. 26p. Dep. NTIS $4.00.

It is stated that all work and opinions expressed in the report should be regarded as speculative. The presentation is divided into sections under the task titles: (1) estimates—future product demands; (2) ownership issues; (3) management issues; (4) economic issues; and (5) lifestyle and energy consumption—scenarios for the years 1985, 2000, and 2025. (EJH)

4487 (FE—1772-6) **Engineering Support Services Clean Boiler Fuel Demonstration Plant. Quarterly technical progress report for May 28, 1975—September 30, 1975.** (Dravo Corp., Pittsburgh, Pa. (USA). Chemical Plants Div.). 15 Oct 1975. Contract E(49-18)-1772. 12p. Dep. NTIS $4.50.

The objectives of this work are to investigate independently proposed innovative concepts and provide sufficient information to the Government for reasonable evaluation of technical, cost, and schedule trade-offs; to verify the design and engineering of the high risk components and to verify the fail safe criteria; to provide an independent estimate of component life expectancy, reliability, and maintainability; to validate scaling laws proposed for coal conversion processes; and to develop valid uniform procedure for comparing plant and processes designs. Several task assignments have been received, and the status of each assignment is given. The site evaluation survey has been completed; there has been a delay in the environmental studies; the conceptual commercial design is proceeding after a two-month delay; and work on the Handbook on Gasifiers and Gas Treatment Systems is well under way. (auth)

4488 (FE—1774-T1) **Advanced anthracite technology and research. Final report. Proceedings of the conference held at the University of Scranton, Scranton, Pennsylvania on January 6 and 7, 1975.** Burti, U.H.; Kalafut, J.R. (Scranton Univ., Pa. (USA)). 1975. Contract E(49-18)-1774. 206p. (CONF-750132—). Dep. NTIS $7.60.

From Conference on advanced anthracite technology and research; Scranton, Pennsylvania, USA (6 Jan 1975).

Following the Executive Summary, this report is constituted of four major sections that reflect the manner in which the Conference was conducted. Each section consists of the Conference Workshop recommendations followed by the text of the two invited papers presented by the resource persons assigned to that workshop. The papers were presented during the first day of the Conference and the recommendations formulated by the specific workshop chairman on the basis of extensive discussions by all participants on the second day. The participants were broadly charged with the evaluation of the technical and environmental constraints on the markets, extraction, utilization and conversion of anthracite coal. A secondary objective was to indicate how the universities can make an effective contribution, both in research and in providing graduates with the requisite skills for greater development of anthracite resources. (auth)

4489 (FE—1774-T1, pp 7-19) **Final workshop report on potential markets and economic constraints.** Charmbury, H.B. 1975.

From Conference on advanced anthracite technology and research; Scranton, Pennsylvania, USA (6 Jan 1975).

In Advanced anthracite technology and research. Final report.

This section consists of the Summary Report of Workshop A entitled "Potential Markets and Economic Constraints," by H. B. Charmbury; "Historic and Current Production of Anthracite and Related Constraints," by F. H. Mohney; and "Two Economic Scenarios for the Anthracite Regions," by A. E. Smigel. The industry reached its peak in 1917, and one of the major problems now is to reverse the trend by overcoming the problems confronting the industry. Expanded research and development for the utilization of fluidized-bed boilers should be encouraged. Production, transportation, current markets, and potential markets were discussed. Consideration was given to the short-term revitalization of the industry (10 years) and to the long-term supply of anthracite to meet the national energy crisis. (EJH)

4490 (FE—1774-T1, pp 49-54) **Final workshop report on utilization and conversion technology.** Spackman, W. 1975.

From Conference on advanced anthracite technology and research; Scranton, Pennsylvania, USA (6 Jan 1975).

In Advanced anthracite technology and research. Final report.

This section consists of the Summary Report of Workshop B entitled "Utilization and Conversion Technology," by W. Spackman; "Utilization and Conversion Technology-Present Technologies and Problems," by R. H. Demmy; and "Anthracite Conversion and Utilization," by P. S. Lewis. The chief topics covered were: available technolgies that should be exploited, economic incentives for industry, technical constraints on anthracite utilization, political constraints on anthracite utilization, recommended areas of research and development, priorities, and role of the universities. (EJH)

4491 (FE—1774-T1, pp 82-104) **Final workshop report on extraction technology: deep mining of anthracite.** Manula, C.B. 1975.

From Conference on advanced anthracite technology and research; Scranton, Pennsylvania, USA (6 Jan 1975).

In Advanced anthracite technology and research. Final report.

This section consists of the Summary Report of Workshop C entitled "Extraction Technology-Deep Mining," by C. B. Manula; "Past and Present of Deep Mining- Extraction Technology," by D. R. Maneval; and "Research and Development for Deep Anthracite Mining," by R. L. Marovelli. methods were discussed for expanding the production of anthracite and giving incentives to the industry while meeting governmental environmental and health and safety standards. (EJH)

4492 (FE—1774-T1, pp 163-178) **Final workshop report on anthracite surface mining: extraction technology.** Heine, W.N. 1975.

From Conference on advanced anthracite technology and research; Scranton, Pennsylvania, USA (6 Jan 1975).

In Advanced anthracite technology and research. Final report.

This section consists of the Summary Report of Workshop D entitled "Extraction Technology - Surface Mining," by W. N. Heine; "Current Technologies and Problems of Anthracite Surface Mining," by R. W. Rissinger; and "Constraints to Increased Productivity from Anthracite Strip Mines," by A. B. Riedel. Attention was focused on the industry as it once was, as it is now, and as many hope it to be. This included economic planning, role of government, need for government assistance, environmental protection, surface mining equipment and development, training needs, and research and development. (EJH)

4493 (FE—1775-2) **Preliminary design services research and development report No. 114, July—September 1975. Interim report No. 2.** (Parsons (Ralph M.) Co., Pasadena, Calif. (USA)). Nov 1975. Contract E(49-18)-1775. 17p. Dep. NTIS $3.50.

The objective of the work is to develop preliminary designs and economic evaluations for a number of coal conversion plants. The following designs are included in the scope of work: a conceptual commercial plant for a Coal-Oil-Energy-Development (COED) plant; an Oil/Gas plant to produce liquid fuels plus substitute natural gas (SNG); a commercial-scale Fischer-Tropsch plant with motor fuel and SNG as the main products; a commercial-scale plant for the production of solvent-refined coal (SRC); a Coal Oil Gas Refinery (COG) to produce clean liquids, gas and electrical power generating capacity; and a facilities complex capable of demonstrating the commercial feasibility of a variety of coal conversion processes that show promise during pilot plant operations. The following facilities will be considered; conversion of coal to low to high Btu fuel gas methanol/motor fuel by Fischer-Tropsch process; and clean liquid fuels by alternate liquefaction processes. In addition, supporting efforts will be provided to the above activities. These efforts include planning and progress monitoring, equipment development, and environmental factors. (auth)

PROCESSING

4494 (ORNL—5049) **Coal technology program quarterly progress report No. 2 for the period ending March 31, 1975.** (Oak Ridge National Lab., Tenn. (USA)). Aug 1975. Contract W-7405-eng-26. 71p. Dep. NTIS $5.45.

CARBONIZATION

4495 (UKY-TR—74-CME3) **Synthetic oil from coal. First annual report.** Kermode, R.I. (Kentucky Univ., Lexington (USA)). Nov 1974. 17p. Univ. of Kentucky, Lexington.

The hydrogen study proceeded with completion of the material and energy balance description of the partial oxidizer and water gas shift reactor. Considerable time was devoted to establishing flowsheets and operating conditions for the two acid gas removal systems. Several changes were made in the Ashland carbonizer. These were primarily in the product recovery system where a packed scrubber was added to eliminate tars that were causing serious plugging problems. Runs have been made using a 50-50 char-coal feed. Many of them were terminated because of operating problems either in the feed system, the reactor, or product-recovery system. The continuous flotation cell was completed and six preliminary runs were made. In all runs but one the material balance closure was poor, making it difficult to judge the effectiveness of continuous flotation as a means of ash removal. Four petroleum fractions and one coal liquid were used as the organic phase for the flotation. Two of the petroleum fractions exhibited the characteristics of containing a natural surfactant; separations of 10 to 50 percent were obtained. Flotation using all other solvents was unsuccessful. A series of runs using a factorial design is presently underway to determine the most important individual variables plus interactions. (auth)

DESULFURIZATION AND PURIFICATION

4496 (FE—496-T5) **Development of a process for producing an ashless, low-sulfur fuel equipment and its operation for hydrotreating of a coal-derived liquid. Interim report No. 14.** Wan, K.T. (Oklahoma State Univ., Stillwater (USA)). May 1973. Contract E(49-18)-496. 60p. Dep. NTIS $5.45.

Thesis.

The major emphasis was to establish equipment operability and variable ranges for further studies of hydrotreating a coal-derived liquid. A commercial catalyst consisting of CoO and MoO_3 was used in a trickle-flow reactor at temperatures of 600, 700, and 800°F (315.6, 371.1, and 426.7°C); pressures of 500, 1000, and 200 psig, and space times of 0.216, 0.435, 0.901, and 1.802 cc catalyst/cc feed oil per hour. Equipment operability was established. Experimental results reveal that desulfurization, denitrogenation, and hydrocracking increase with increasing temperature, pressure, and space time, although their sensitivities with respect to the variables differ. Maximum removals obtained at 800°F, 2000 psig, and 1.802 cc catalyst/cc feed oil/hr were 92 percent for S and 84 percent for Ni. Data obtained in this work will serve as a reference set of data for catalyst development comparison. (auth)

4497 (FE—496-T8) **Development of a process for producing an ashless, low-sulfur fuel from coal. Volume IV. Product studies. Part 8. A preliminary study of non-catalyzed hydrodesulfurization of coal derived liquids. Interim report No. 17, July 1974.** Chirakaparambil, F.G. (Oklahoma State Univ., Stillwater (USA)). Jul 1974. Contract E(49-18)-496. 85p. Dep. NTIS $5.45.

Thesis.

A hydrodesulfurization study on coal-derived liquids, was the objective of this work. The hydrotreating reaction was conducted in a trickle flow reactor packed with crushed berl saddles. Temperature and space time were found to be influencing process variables in the non-catalyzed hydrodesulfurization reaction. The effect of pressure increase from 500 to 1500 psig was noted at the high temperature of 800°F. The combined effect of low pressure and high temperature favored the non-hydrogenative thermal cracking of the feed oils. In general, the desulfurization of the feed oils was relatively low in the non-catalyzed hydrodesulfurization experiment over the range of variables studied. (auth)

4498 (FE—1225-1) **Research on sulfur removal from coal by treatment with hydrogen. Quarterly progress report, April—June 1975.** Gary, J.H.; Baldwin, R.M.; Dickerhoof, D.W. (Colorado School of Mines, Golden (USA)). 15 Jul 1975. Contract E(49-18)-1225. 29p. Dep. NTIS $4.00.

Research is being conducted with the goal of producing an environmentally acceptable fuel from coal. This fuel may be either solid or liquid, depending upon processing conditions and operational mode chosen. Environmental Protection Agency Ambient Air Quality Standards are being used as guidelines for fuel quality. An ash-containing, low-sulfur, low-nitrogen fuel that may be burned in new and existing power generating facilities is the ultimate objective. The work scope covers sulfur removal using nascent hydrogen in a bench-scale pilot plant, catalytic hydrodenitrogenation of coal-derived liquids, improved solid-liquid separation characteristics for coal liquids and improved analysis techniques for sulfur, nitrogen and characteristic compounds found in coal liquids. The process under development uses conventional chemical engineering equipment and does not utilize the consumption of pure hydrogen in the initial liquefaction/desulfurization step. Such a process will ultimately allow greater utilization of our fossil fuel reserves without deteriorating the environment by the emission of harmful pollutants. (auth)

HYDROGENATION

4499 (PERC—0009-1) **In situ conversion of coal (GO155104). Quarterly report No. 1.** Larsen, J.W. (Tennessee Univ., Knoxville (USA). Dept. of Chemistry). 26 Sep 1975. Contract E(36-2)-0009. 3p. Dep. NTIS $4.50.

On the basis of reports in the literature of the successful hydrogenation of aromatic compounds using stearate salts of several metals, an attempt was made to use the stearates of Ni and Cu for this purpose. Although this attempt was not successful, further experiments are underway with polycyclic aromatics. (EJH)

GASIFICATION

4500 (CONF-750306—2) **Energy recovery from in situ coal gasification.** Fischer, D.D.; Brandenburg, C.F.; Schrider, L.A. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). 1975. 7p. Dep. NTIS $4.50.

From 15. annual ASME symposium; Albuquerque, New Mexico, USA (6 Mar 1975).

Estimates of the energy balance for the first underground coal gasification experiment at Hanna, Wyoming, have been calculated for a $5^1/_2$-month period from mid-September 1973 through February 1974. Operating results were the most favorable during this period with dry gas production rates averaging 1.6 million standard cubic feet per day (44,800 Nm^3/day) at an average gas heating value of 126 Btu per standard cubic foot (1,122 kcal/Nm^3). The ratio of energy produced to energy consumed in running the experiment was approximately 4 and the overall efficiency was approximately 50 percent. Use of more efficient air compression equipment and of a system designed for combustion of low-Btu gas could increase this ratio to 8 and efficiency to 55 percent. (auth)

4501 (CONF-750868—1) **Behavior of caking coals in fixed-bed gasifiers.** Liberatore, A.J.; Gillmore, D.W. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). 1975. 17p. Dep. NTIS $4.50.

From 2. annual symposium on coal gasification, liquefaction and utilization best prospects for commercialization; Pittsburgh, Pennsylvania, USA (5 Aug 1975).

Low-Btu gas from high S coal offers a promising method of producing an economical and environmentally acceptable fuel for utility plants. Low-Btu gas is envisioned for use in conventional

steam boilers operating at atmospheric pressure or in advanced, combined gasrsteam turbine cycles at elevated pressures. Previous research at the Morgantown Energy Research Center with a 42-in. dia, stirred fixed-bed gasifier, showed that deep continuous stirring of the fuel bed facilitated gasification of caking coals. Stirring breaks up agglomerates and fills void spaces in the bed, thereby promoting better gas-solid contact. Stirring also prevents the formation of massive clinkers, thus facilitating the passage of ash and clinkers through the grate. (auth)

4502 (CONF-750870—1) **Behavior of caking coals in fixed-bed gasifiers.** Gillmore, D.W.; Coates, N.H. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). 1975. 9p. Dep. NTIS $4.50.

From Coal agglomeration and conversion symposium; Morgantown, West Virginia, USA (25 Aug 1975).

Gasification of coal with air and steam produces a low-Btu fuel gas (130-170 Btu/scf) suitable for firing industrial furnaces, powerplant boilers, or combined gas-steam turbine cycles. However, commercial fixed-bed gasifiers currently available can use only closely-sized, non-agglomerating coals. The Morgantown Energy Research Center has developed a stirred, fixed-bed gasifier that will process strongly caking coals, including the fine sizes. This 42-in.-dia gasifier is described, and operations with Appalachian coals are discussed. (auth)

4503 (CONF-751035—1) **Review of coal conversion technology.** Pickel, T.W. (Oak Ridge National Lab., Tenn. (USA)). 1975. 13p. Dep. NTIS $4.00.

From Meeting of review of coal conversion technology; Knoxville, Tennessee, USA (7 Oct 1975).

An outline of the presentation and representations of the slides used are given. The introduction covered the goals of the program, the history of coal conversion, and orientation numbers to illustrate the magnitude of the problem. Coal gasification was described by means of a flowsheet. Coal liquefaction was covered under the headings: solvent refined coal, hydrocarbonization, direct hydrogenation, solvent extraction-hydrogen donor, comparison of processes, and development areas. A comparison of some coal liquefaction processes is presented in tabular form. (EJH)

4504 (CONF-751215—1) **Pressurized, stirred, fixed-bed gasification.** Gillmore, D.W.; Liberatore, A.J. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). 1975. 20p. Dep. NTIS $4.50.

From EPA symposium on environmental aspects of fuel conversion technology; Hollywood, Florida, USA (15 Dec 1975).

Morgantown Energy Research Center (ERDA) has been operating a 42-in.-dia, pressurized, stirred, fixed-bed gasifier to define operating parameters for various coals and develop technology for commercial scale. Recently, emphasis has been focused on the detailed analysis of gaseous and liquid products and the current program reflects this objective. Some data are reported on the analysis of tar and gaseous constituents. (auth)

4505 (FE—381-T9-P1) **HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 1.** (Institute of Gas Technology, Chicago, Ill. (USA)). Jul 1975. Contract E(49-18)-381. 399p. Dep. NTIS $11.75.

This report, in addition to a table of contents for the nine parts of FE-381, consists of two parts: Part I: Summary and Part II: Hydrogasification in 4-inch PDU. An abstract has been prepared for each of these two parts. (EJH)

4506 (FE—381-T9-P1, pp vp Pt.1) **Introduction to the report.** Jul 1975.

In HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 1.

After an introduction to the report that contains an outline of the nine parts that are to appear in four volumes, the summary consists of the following parts that cover the remaining portions of the report: Hydrogasification in the 4-Inch PDU; Pilot Plant Development; Hydrogen Generation; Methanation; Coal and Char Characterization; Coal Pretreatment in the 10-Inch PDU; Commercial Plant Design; and Process Economics. Following the Summary there is a High-Btu Bibliography consisting of 398 references. (EJH)

4507 (FE—381-T9-P1, pp vp Pt.2) **Hydrogasification in the 4-inch PDU.** Jul 1975.

In HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 1.

More than 250 coal hydrogasification tests were performed under a variety of conditions and utilizing many types of coal in combination with a variety of gaseous feeds during the period from 1964 to 1972. The work was performed in a 4-in.-dia. reactor termed the hydrogasification process development unit (PDU), which is described in its various configurations. The results of the PDU hydrogasification work helped to confirm early HYGAS concepts and played a significant role in shaping criteria for design of the HYGAS pilot plant reactors. (auth)

4508 (FE—381-T9-P2) **HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 2.** (Institute of Gas Technology, Chicago, Ill. (USA)). Jul 1975. Contract E(49-18)-381. 445p. Dep. NTIS $12.75.

An abstract was prepared for each of the two parts of this report. (EJH)

4509 (FE—381-T9-P2, pp vp Pt.3) **Pilot plant development.** Jul 1975.

In HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 2.

Detailed discussion covers process chemistry, preliminary plant design, design modifications and construction, and start-up operations. The HYGAS process for the hydrogasification of coal is tailored to maximize the direct production of methane in the hydrogasification reactor by the use of high temperature (1200-1850°F) and high pressure (1000 psig). The process can use feed caking bituminous coals as well as noncaking lignite and subbituminous coals. Of the total methane formed in the HYGAS process, 65 to 70 percent is directly formed in the hydrogasifier. This is a key feature of the process, and contributes significantly to the high overall thermal efficiency of more than 70 percent. The second key feature of the process is the use of hydrogen and steam in hydrogasification. The coal-hydrogen reaction, coal + $2H_2$ yields CH_4, is strongly exothermic, while the coal-steam reaction, coal + H_2O yields $CO + H_2$, is strongly endothermic. By using a mixture of hydrogen and steam instead of hydrogen alone, the heat released by the first reaction is absorbed in situ by the second reaction, resulting in built-in temperature control and internal hydrogen generation. The raw gas from the hydrogasifier contains CO and H_2. These are converted to methane through the third reaction, $CO + 3H_2$ yields $CH_4 + H_2O$, in the catalytic clean-up methanation unit, where the CO content is reduced to the pipeline standard of less than 0.1 percent, and the heating value of the product gas is raised to satisfactory SNG levels. (auth)

4510 (FE—381-T9-P2, pp vp Pt.4) **Hydrogen generation.** Jul 1975.

In HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 2.

This part contains a summary of hydrogen generation; the electrothermal/300 kW (6-inch) unit; the electrothermal/2.25 MW (30-inch) unit; steam-oxygen gasification; and steam-iron gasification. Operating conditions are tabulated in detail, and diagrams of the apparatus are shown. (EJH)

4511 (FE—381-T9-P3) **HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 3.** (Institute of Gas Technology, Chicago, Ill. (USA)). Jul 1975. Contract E(49-18)-381. 408p. Dep. NTIS $12.00.

An abstract was prepared for each of the three parts of this report. (EJH)

4512 (FE—381-T9-P3, pp vp Pt.5) **Methanation.** Jul 1975.

In HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 3.

Work carried out on the evaluation of catalysts for the methanation of coal gasification effluent gas streams (to raise the heating value to the level of pipeline gas) is reported. The "perfect-mixing" zone for the CSTR (continuous-stirred-tank reactor) eliminates the temperature and concentration gradients, and permits an easier evaluation of the kinetics of a chemical reaction. Catalyst properties evaluated were activity, physical strength, upper and lower temperature limits, resistance to poison, selectivity for methanation reaction, and the life performance. For most of the catalysts studied, the H_2:CO ratio in the feed gas should not be less than 2.85 for the temperatures between 525 and 900°F and for pressures above 600 psig. The presence of large amounts of CH_4 in the feed gas has a small effect on the rate of methanation as long as its relative partial pressure is low compared to that of H_2. Most of the catalysts were not regenerable after benzene deactivation. If both CO and CO_2 are present in the feed, CO_2 will be hydrogenated to methane only when the concentration of CO is less than 0.2 mole percent. Excess CO_2 (15 percent or more) may hinder the CO methanation reaction. The presence of N_2 in the coal gasifier effluent (methanator feed) may cause NH_3 formation because Ni and Fe in the catalyst (or in the reactor walls) promotes NH_3 formation in the absence of carbon oxides. Ammonia tends to deactivate the methanation catalyst, but it can be regenerated by passing H_2 at about 700°F. Small concentrations

(less than 1 ppM) of C_3H_7SH and thiophene do not affect the Ni catalysts. However, CH_3SH, COS and H_2S in excess of 1.2 ppM quickly poison the Ni catalysts. Life testing results of three promising catalysts are summarized. (EJH)

4513 (FE—381-T9-P3, pp vp Pt.6) **Coal and char characterization.** Jul 1975.

In HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 3.

This part contains sections on petrography and related studies; miscellaneous support studies; calorimetry; and kinetics of coal gasification. Petrographic study of feed coals and some of their chars has helped in explaining some anomalous hydrogasification processing results. Laboratory tests on the slurrying of coal and char were performed prior to the pumping tests. Calorimetry research was required to establish valid data on various heats of reactions upon which to base the design of an efficient coal hydrogasification plant. A quantitative mathematical model to describe coal char gasification kinetics was developed on the basis of experimental information obtained over a wide range of conditions. (EJH)

4514 (FE—381-T9-P3, pp vp Pt.7) **Coal pretreatment in 10-inch PDU.** Jul 1975.

In HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 3.

The most reactive part of coal for producing CH_4 is contained in the volatile matter of coal, a fact that favors the use of high-volatile coals to synthesize substitute natural gas (SNG) for pipeline use. As a result of a literature review and batch pretreatment tests with air and N_2, it was concluded that oxidation with air or diluted air was the most suitable method of destroying caking properties of bituminous coal with minimum loss of the valuable volatile matter. A fluidized-bed unit was constructed and several tests were conducted at near-atmospheric pressure with high-volatile bituminous coal. Tests also were made with this coal at pressures up to 1055 psig utilizing a high-pressure reactor. The objectives of the work were: development of a satisfactory, continuous, atmospheric-pressure fluidized-bed pretreatment unit and process; establishment of minimum pretreatment conditions for the complete range of rank of bituminous coal; and preparation of pretreated coal for the 4-inch.-dia hydrogasification process development unit. Conditions necessary to destroy the agglomerating tendency of caking coals with minimal pretreatment using air or diluted air were established in an atmospheric-pressure fluidized-bed reactor. For high-volatile bituminous coals, which are commercially significant for SNG production, the successful pretreatment conditions were: temperature above 735°F; oxygen consumption of 1.0 to 2.5 scf/lb coal fed; and residence time exceeding 10 min. The volatile matter in the coal was reduced from a range of 33 to 39 percent to a range of 24 to 26 percent before free-flowing char was produced which could be continuously fed to the hydrogasifier. (auth)

4515 (FE—381-T9-P4) **HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 4.** (Institute of Gas Technology, Chicago, Ill. (USA)). Jul 1975. Contract E(49-18)-381. 588p. Dep. NTIS $14.75.

An abstract was prepared for each of the two parts of this report. (EJH)

4516 (FE—381-T9-P4, pp vp Pt.8) **Commercial plant design.** Jul 1975.

In HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 4.

The design of a HYGAS demonstration plant is discussed. It is based on technology existing in December 1969. The plant design incorporated the electrothermal process for manufacture of hydrogen-rich gas because that process was most advanced at that time. Extensive research and development by IGT for OCR and others has since proved that two alternative systems for producing hydrogen-rich gas, namely the steam-oxygen and steam-iron processes, may be even more promising on the basis of current economics. Facilities for extensive testing of these processes at the HYGAS pilot plant are being readied. Because the design discussed was an early design and progress in the hydrogasification of coal to high-Btu gas for pipeline use has been substantial since 1969, a critique of the design also is presented together with suggested areas of improvement. Progress has been achieved in most of the improvement areas discussed since this work was performed. The purpose of the early demonstration plant design in 1969 was to provide a guide for future designs, both in the arrangement and sequence of processing steps; to pinpoint problem areas where pilot-scale study should be concentrated; and to pinpoint problem areas where a paucity of existing data might indicate additional basic research would be required; all of these goals have been accomplished. The primary impact of this design, however, has been to show that it is feasible to design large-scale plants for the hydrogasification of coal to pipeline-quality gas (SNG), with new American approaches to gasification, coupled with existing technology. As any of the desirable improvements discussed become available, both the economics and design of coal gasification plants will benefit. This design project indicates, however, that commercial conversion of coal to SNG is feasible today with improved American technology, without awaiting advances to optimum designs. (auth)

4517 (FE—381-T9-P4, pp vp Pt.9) **Process economics.** Jul 1975.

In HYGAS: 1964 to 1972. Pipeline gas from coal—hydrogenation (IGT hydrogasification process). Volume 4.

Several studies pertaining to the economics of the HYGAS process for the conversion of coal to pipeline-quality SNG were performed. No data are presented here, but a bibliography consisting of eight references to interim reports is included. (EJH)

4518 (FE—1207-I(Vol.1)) **Gas generator research and development BI-GAS process. Interim report, October 1, 1970—May 31, 1974.** (Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). Nov 1974. Contract E(49-18)-1207. 127p. Dep. NTIS $13.60.

This first of three volumes constituting the report contains a complete summary of the work, an introduction, a description of the BCR two-stage gasification process, and a selection on coal composition and beneficiation studies. Continued operation of the 100 lb/hr Stage 2 process and equipment development unit (PEDU) supplied reliable information for further evaluation of the direct methanation process. Coals ranging in rank from lignite to high volatile A bituminous coal were tested in the PEDU under a wide range of conditions without pretreatment of the coal and without formation of tar in the process. Yields of methane directly from bituminous coal were higher than predicted from consideration of results obtained in previous tests in a smaller reactor. With proper design of the Stage 2 section to avoid recirculation of product methane into areas of high temperature, the 5 ton/hr integrated two-stage slagging gasifier can be expected to produce methane yields in excess of those obtained in the Stage 2 PEDU. Inasmuch as increased yields of methane directly from coal in the gasifier may significantly affect the final pipeline gas cost in a commercial plant, a bench-scale method was developed to assay samples of coal to determine the yield of methane in the gases collected by this method. In addition, standard techniques of beneficiating coals to produce gas-rich fractions were studied. In certain cases, a gas-rich separate was obtained in greater concentration than would be expected by normal mineral removal. Beneficiation was not effective on all the coals tested, nor was each method equally effective on a single coal. (EJH)

4519 (FE—1207-I(Vol.2)) **Gas generator research and development BI-GAS process. Interim report, October 1, 1970—May 31, 1974.** (Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). Nov 1974. Contract E(49-18)-1207. 342p. Dep. NTIS $13.60.

Previously, the principal effort on the experimental program had been devoted only to the optimization of Stage 2 operating conditions for the two-stage gasifier. During this report period, effort was devoted to other unit operations; namely, catalytic methanation of the gases from the two-stage gasifier to produce a high-Btu pipeline-quality gas. Conventional methanation systems are generally based on Ni catalysts in fixed beds. To aid in the selection of catalyst types, supplied by catalyst manufacturers through secrecy agreements, a bench-scale methanator (BSM) was constructed to obtain kinetic data on the conversion of carbon oxides to hydrocarbons under the conditions imposed by the BI-GAS process. A small life test unit was also constructed to obtain reactivity data of various catalysts over a relatively long period of time. With the aid of a subcontractor, Koppers Company, Inc., a process and equipment development unit (PEDU) was designed and constructed to study the fluidized-bed methanator on a larger scale. The 6-in.-dia. reactor is capable of handling 6000 scfh of CO and H_2 at 1050°F and 1650 psig. Data from the PEDU will be used to design the Homer City BI-GAS pilot plant methanator. Startup operations of the PEDU began in June 1973, and the first catalyst test was made in October 1973. Promising catalysts obtained from bench-scale tests will be scheduled for other methanation PEDU tests. (EJH)

4520 (FE—1207-I(Vol.3)) **Gas generator research and development BI-GAS process. Interim report, October 1, 1970—May 31, 1974.** (Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). Nov 1974. Contract E(49-18)-1207. 246p. Dep. NTIS $13.60.

Data processing and data acquisition systems were developed as a result of the experimental programs conducted. A

computer simulator for the BI-GAS process predicts gas yields and material and energy balances for gasification of any type of coal in the two-stage process. In conjunction with the bench-scale and PEDU-scale methanation systems, data processing capability was expanded and direct data acquisition systems were developed. Development of procedures for gas analysis was continued. Experiments in a full-scale model of the reactor were conducted to establish the optimum orientation of nozzles for injecting coal into Stage 2 and char into Stage 1 of the two-stage gasifier. Information from these tests was used in the final design of the pilot plant gasifier. A bid package for a 5 ton/hr oxygen-blown gasifier was prepared and the contract construction and operation of the pilot plant awarded. The facility is currently being constructed at Homer City, Pennsylvania. Projections concerning commercial-scale operation of the BI-GAS process have been made using data and information from the experimental investigations, and were reported earlier. During this report period, other evaluations of the process, as requested and approved by the sponsors, are presented. (EJH)

4521 (FE—1767-3) **Mixing and gasification of coal in entrained flow systems. Quarterly technical progress report, 1 July 1975—30 September 1975.** Smoot, L.D.; Hanks, R.W. (Brigham Young Univ., Provo, Utah (USA)). 15 Oct 1975. Contract E(49-18)-1767. 22p. Dep. NTIS $4.50.

Non-reacting mixing tests were made. The causes of a previously reported system misalignment problem leading to flow asymmetry were identified and are being corrected. Modifications of the test facility to allow recirculating flow studies has begun. On the basis of the reoptimization of the test program reported last time, the redesign of the high-pressure test facility has progressed, firm decisions as to sizes and capacities have been made, and the feeder, reactor, and exit scrubber have been designed and construction initiated. A supply of pulverized coal for use in the testing program has been obtained and is being analyzed. Preliminary calculations using the recirculating flow model appear to be reasonable and are very encouraging. Development of this model is progressing satisfactorily. During the next quarter, continued design and construction of the high-pressure gasification test facility, measurement of mixing rates in nonreacting jets, and development of the predictive models will be emphasized. It is anticipated that a major portion of the construction and assembly of the high-pressure gasification test facility will be completed. (auth)

4522 (FE—1814-1) **Catalytic synthesis of gaseous hydrocarbons. Quarterly report, May—August 1975.** Dent, A.L. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). Aug 1975. Contract E(49-18)-1814. 41p. Dep. NTIS $4.00.

The objectives are to develop improved catalyst systems for preparation of gaseous hydrocarbons from coal-derived mixtures of carbon monoxide and hydrogen and to develop a fundamental understanding of methanation and Fischer-Tropsch synthesis. The progress made in the assembly of a catalytic reactor unit and its calibration, the preparation or procurement of several Fe, Co, and Ni based catalysts and their characterization, and the development of an infrared technique to study the mechanisms on unsupported metal catalysts are reported. The development of a routine method for the generation of a Ni aerosol by arc vaporization techniques is described. The results of characterization of the aerosol by BET surface area measurements and ethylene hydrogenation activity are reported. (JSR)

4523 (ORNL-TM—5186) **Coal technology program progress report for October 1975.** (Oak Ridge National Lab., Tenn. (USA)). Dec 1975. Contract W-7405-eng-26. 21p. Dep. NTIS $4.50.

This report, the fifteenth of a series, is a compendium of monthly progress reports for the ORNL research and development projects that are in support of the increased utilization of coal as a source of clean energy. The projects reported this month include those for hydrocarbonization, solid-liquid separations, chemical research and development, analytical chemistry, engineering evaluations of nuclear process heat for coal conversion, coal-fueled MIUS, engineering evaluations of the Hydrocarbonization and Synthoil processes, and biomedical and environmental research. (auth)

4524 (UCRL-Trans—10984) **Physical and chemical fundamentals of fuel combustion and gasification. XII-5. Gas formation in a coal seam during underground gasification.** Lavrov, N.V. Nov 1975. Translated from pp 239-250 of Fiziko-khimicheskie osnovy goreniya i gazifikatsii topliva, State Scientific-Technical Publishing House for Literature on Ferrous and Nonferrous Metallurgy, Moscow, 1957. 30p. Dep. NTIS $4.00.

The development of the underground gasification of coal in the USSR is reviewed. At one of the stations gas has been produced with a heating capacity of 850 kcal/nm^3, suitable for power generation, for more than ten years. Two boreholes are drilled from the surface to the coal seam. One serves for injection of draft and the other for venting of the gas. The method of linking the wells is discussed. Variations in the composition of gas produced in underground coal gasification demonstrate that large amounts of CO are produced. Gas formation in an underground gas producer is rather unclear because of the great complexity of the process and also because of the difficulties associated with underground experimentation at relatively great depths. (EJH)

LIQUEFACTION

4525 (FE—1224-41) **Project Lignite quarterly technical progress report No. 3, October—December, 1974.** Severson, D.E. (North Dakota Univ., Grand Forks (USA)). 15 Jul 1975. Contract E(49-18)-1224. 26p. Dep. NTIS $5.00.

Tests in which lignite was dried in the batch autoclave with solvent indicated that there was no generation of solvent-type material. In fact, appreciable solvent was retained by the lignite and there was no reduction in S content. First and second pass tests in the solvent-recycle series using FS-120 as initial solvent to produce coal-derived solvent indicated no appreciable degradation of solvent or reduction in liquefaction. Variation in heating rates between autoclaves under otherwise similar experimental conditions apparently resulted in some differences in liquefaction characteristics. Hydrogenation of Solvent-Refined Lignite (SRL) in University Supporting Research work indicated that the highest yields of gases and distillable products were obtained at solvent: SRL ratio of 1:1. Higher or lower ratios gave lower conversions. Low solvent: SRL ratios with tetralin as solvent increased concentrations of aromatics in hydrogenation products. Conversions in hydrogenations with FS-120 as solvent were nearly as high as with tetralin. Ni-Mo-Al_2O_3 was shown to be a superior hydrogenation catalyst in comparison with Ni-W-SiO_2-Al_2O_3. Fast fluidization of -100 mesh catalyst particles was achieved at air velocities of 4.33 to 7.48 ft/sec at feed rates to 5 lb/hr giving bed densities as high as 15 lb/cu ft. Air velocities of 9.77 ft/sec were required for fast fluidization of sand particles. At slightly higher velocities, unstable conditions occurred with the experimental equipment used. (auth)

4526 (FE—2007-4) **Filtration process and equipment studies for coal liquefaction processes. Phase I. Quarterly report, July—August 1975.** Hutto, F.B.; Himes, R.C. (Johns-Manville Sales Corp., Denver, Colo. (USA)). 12 Sep 1975. Contract E(49-18)-2007. 14p. Dep. NTIS $4.00.

Progress made toward the objectives of the subject project in the period from inception (May 22, 1975) to the end of August 1975 is reported. This progress relates principally to Task I, "Design and Construction of Laboratory Test Facility." The work has involved detailed development of: (1) an appropriate experiment concept and (2) a design of apparatus in which the experiment may be conducted at temperatures up to 750°F and pressures up to 400 psig. These sub-tasks have been completed, and appropriate equipment and components designed and ordered. The principal pressure vessel has been fabricated, mounted on the support frame designed and built for this purpose, and installed in the specially ventilated and equipped room built to house this apparatus. Work of fitting this vessel with all components required for operation of the filtration system is proceeding. (auth)

SOLVENT EXTRACTION

4527 (FE—2003-3) **Chemical characterization, handling, and refining of SRC to liquid fuels. Quarterly progress report, June—September 1975 .** Greskovich, E.J. (Air Products and Chemicals, Inc., Allentown, Pa. (USA)). 30 Sep 1975. Contract E(49-18)-2003. 35p. Dep. NTIS $4.00.

The objective of the research program is to characterize the inherent physical and chemical properties of solvent-refined coal (SRC) and to develop optimum methods for the desulfurization, denitrogenation, and hydrocracking of SRC using commercially available catalysts. The work plan consists of the following tasks: (1) literature survey; (2) chemical and physical characteristics of SRC and distillate materials; (3) handling characteristics of SRC; (4) design and construction of a test unit; (5) desulfurization and denitrogenation of SRC; and (6) hydrocracking studies. (EJH)

PROPERTIES

4528 (PERC/RI—75/5) **Mass spectrometric analysis of streams from coal gasification and liquefaction processes.** Sharkey, A.G. Jr.; Shultz, J.L.; Schmidt, C.E.; Friedel, R.A. (Energy Research and Development Administration, Pittsburgh, Pa. (USA). Pittsburgh Energy Research Center). Nov 1975. 28p. Dep. NTIS $4.00.

The increased effort in developing coal hydrogenation and coal gasification processes has emphasized the need for additional methods to analyze coal-derived fuels. Mass spectrometry is playing a major role in analyzing many of the streams from the Pittsburgh Energy Research Center's SYNTHANE and SYNTHOIL processes. Streams from coal gasification and coal hydrogenation processes are outlined and examples given for the analysis of coal, gas, oil, tar, and process water. Deficiencies in current mass spectrometric methods as applied to coal-derived fuels are reviewed and needs for future analytical research are discussed. (auth)

4529 (UCRL-Trans—10955) **Rheological study of coal and coal charges used for coking.** Geguchadze, R.A. Translated from *Tr. Inst. Goryuch. Iskop., Moscow;* **27**: No. 2, 10-26(1972). 21p. Dep. NTIS $4.50.

A rheological study was made of coke charges and of the individual types of coal comprising these charges in the plastic state for coke by-product plants. Rheological indices of plasticity were determined, including fluidity indices, the swelling index, and the rate of degradation and rate of flow of the coal; the specific properties of the coals and charges in the plastic state and their changes as a function of temperature were determined. The coals and charges are characterized by different temperatures of apparent fluidity. The ultimate shear stress of the plastic mass at different specific pressures depends on the caking capacity of the coals. The comparative features of five coal charges in the plastic state, which are related to the physicomechanical properties of the metallurgical coke produced from these charges, were found on the basis of the rheological study. Rheological evaluation of coals and coal charges will make it possible scientifically to substantiate the interchangeability of coals from different mine seams. (auth)

4530 Neutron activation analysis for trace elements in coals, ashes, and related materials from coal-treatment facilities. Kucera, E.T.; Heinrich, R.R. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc., Suppl.;* **21**: No. 3, 21-22(1975).

From International nuclear and atomic activation analysis conference and 19. annual meeting on analytical chemistry in nuclear technology ; Gatlinburg, TN (14 Oct 1975).

4531 Reactivity of heat-treated coals in carbon dioxide at 900°C. Hippo, E.; Walker, P.L. Jr. (Pennsylvania State Univ., University Park). *Fuel;* **54**: No. 4, 245-248(Oct 1975).

Reactivities of sixteen 40 x 100 (U.S.) mesh U.S. coals charred to 1000°C were measured in carbon dioxide at 900°C. Chars derived from coals with less than 80 percent carbon, on a dry-ash-free basis, were the most reactive. These chars also gave the widest spread in reactivity. Plots of inorganic element content in the chars versus reactivity showed that magnesium and calcium are important to char reactivity. Six coals were acid-washed with hydrochloric acid and four coals were further demineralized with hydrofluoric acid. Most acid-treated coals showed a decrease in reactivity; but two coals of high rank increased in reactivity. This increase in reactivity is attributed to the creation of additional porosity as a result of mineral matter removal and thus a reduction in resistance to carbon dioxide diffusion to reactive sites. Two demineralized and two original coals were divided into four size ranges and chars were produced from each size of each coal. Gasification rates increased monotonically with decreasing particle size reacted. (auth)

4532 Mechanism of gas flow through coal. Karn, F.S.; Friedel, R.A.; Sharkey, A.G. Jr. (Pittsburgh Energy Research Center). *Fuel;* **54**: No. 4, 279-282(Oct 1975).

Coals are fossilized plant material plus inorganic silt deposited in irregular layers and containing 1-20 percent void space which provides a medium which is porous to gas flow. Gas flows have been measured using discs of coal cut from several coal seams. Observed flow phenomena include molecular diffusion (low gas pressure, small pores) and bulk diffusion (higher gas pressure, larger pores). In the examples investigated, methane flows ranged from 1.2×10^{-10} cm^2 s^{-1} atm^{-1} for Pittsburgh-seam attrital coal to 2.0 cm^2 s^{-1} atm^{-1} for Oklahoma Hartshorne coal. Flow characteristics have been compared with gas flows observed by Knudsen through glass capillaries. This information can be applied to mine safety and to coal utilization studies. (auth)

WASTE MANAGEMENT

4533 (CONF-751213—3) **Preliminary report on fluid-bed combustion of anthracite wastes.** Wilson, J.S.; Gillmore, D.W. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). 1975. 14p. Dep. NTIS $4.50.

From 4. international conference on fluidized bed combustion; McLean, Virginia, USA (9 Dec 1975).

Millions of tons of anthracite refuse and silt bank materials are potential low-carbon, high-ash fuels for fluid-bed combustion. In preliminary tests in an 18-in.-dia atmospheric pressure fluidized-bed combustor at the Morgantown Energy Research Center (ERDA), Powderly Bank silt (66 percent C, 24 percent ash) and Mid-Valley Bank refuse (25 percent C, 65 percent ash) were successfully burned in 36-in. and deeper beds at temperatures of 1600°F and above. (auth)

4534 Pathways of thirty-seven trace elements through coal-fired power plant. Klein, D.H.; Andren, A.W.; Carter, J.A.; Emery, J.F.; Feldman, C.; Fulkerson, W.; Lyon, W.S.; Ogle, J.C.; Talmi, Y.; Van Hook, R.I.; Bolton, N. (Oak Ridge National Lab., TN). *Environ. Sci. Technol.;* **9**: No. 10, 973-979(Oct 1975).

Coal, fly ash, slag, and combustion gases from a large cyclone-fed power plant 870 MW(e) were analyzed for a suite of elements. Mass balance calculations show that the sampling and analyses were generally adequate to describe the flows of these elements through the plant. Most Hg, some Se, and probably most Cl and Br were discharged to the atmosphere as gases. As, Cd, Cu, Ga, Mo, Pb, Sb, Se, and Zn were quite concentrated in fly ash compared to the slag, and were more concentrated in the ash discharged through the stack than in that collected by the precipitator. Al, Ba, Ca, Ce, Co, Eu, Fe, Hf, K, La, Mg, Mn, Rb, Sc, Si, Sm, Sr, Ta, Th, and Ti show little preferential partitioning between the slag and the collected or discharged fly ash. Cr, Sc, Na, Ni, U, and V exhibit behavior intermediate between the latter two groups. (auth)

ENVIRONMENTAL ASPECTS

4535 Selenium in coal-fired steam plant emissions. Andren, A.W.; Klein, D.H.; Talmi, Y. (Oak Ridge National Lab., TN). *Environ. Sci. Technol.;* **9**: No. 9, 856-858(Sep 1975).

Selenium was measured in coal, slag, and flue gas at the Allen Steam Plant in Memphis, Tenn. Approximately 0.3 percent of the coal-derived selenium was incorporated into slag. Sixty-eight percent of the Se was found on the fly ash particles while the rest was found in the vapor phase. Since the electrostatic precipitators at the plant are very efficient for fly ash removal, 93 percent of the emitted Se existed in the vapor phase. The major part of Se discharge from the steam plant occurs via fly ash removal to nearby slag ponds. All of the selenium in the slag and flue gas exists as elemental Se and is thus not immediately available for plant uptake. Selenium emission rates from data collected at the steam plant were used to calculate the minimum mobilization of Se from coal consumption in the U. S. and world. Calculations indicate that 1.5 to 2.5 times as much Se is mobilized by man through coal burning as by natural weathering. (auth)

MINING

4536 (CONF-751074—1) **Assignment of ERTS and topographical data to geodetic\grids for environmental analysis of contour strip mining.** Durfee, R.C.; Edwards, R.G.; Ketelle, M.J. (Oak Ridge National Lab., Tenn. (USA)). 1975. 55p. Dep. NTIS $5.50.

From International symposium on land use; Phoenix, Arizona, USA (27 Oct 1975).

Computer techniques are presented for converting ERTS classified landcover patterns, Defense Mapping Agency topographic data, and geographical variables from other sources onto a common geodetic grid composed of latitude-longitude cells. Spatial analysis techniques are then used to assess the environmental and aesthetic impact of coal surface mining in the New River basin of East Tennessee. (auth)

4537 (UCID—16950) **Two-dimensional calculations of a five-spot high-explosive array in coal.** Butkovich, T.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Nov 1975. Contract W-7405-Eng-48. 20p. Dep. NTIS $4.50.

Two-dimensional TENSOR code calculations were run in plane geometry on a planned 5-spot high-explosive array experiment in coal at Hoe Creek, Wyoming. The primary objective of the calculations was to attempt to determine whether simultaneous or sequential detonations would cause more rock fracture around the explosive array. A secondary objective was to predict the extent and intensity of fracture. Observed intensity of fracture has been correlated with a code-calculated parameter called failure shear strain (epsilon/sub f/) for an underground nuclear explosive in granite. In a previous high-explosive experiment in a coal outcrop the calculated epsilon/sub f/ was correlated with measured

postshot permeability. The radius out to which epsilon/sub f/ greater than or equal to 0.1 is related to intensely fractured rock, and in the coal outcrop experiment is related to permeability of greater than 100 $(\mu m)^2$ (100 darcies). The radius out to which epsilon/sub f/ greater than or equal to 0.01 is related to observable fracture and in the coal outcrop experiment is related to permeability of greater than 0.5 $(\mu m)^2$ (0.5 darcies). The general results would indicate that there is no significant difference in fracture enhancement between simultaneous or sequential detonations. They also indicate that the center charge in the 5-spot array does not contribute to an increase in fracture enhancement and can be eliminated. Recommendations are made for additional experimental verification of calculational results relating cavity growth, fracture limit, and permeability enhancement. (auth)

4538 (UCRL—51876) **Analytical modeling of mine roof behavior using statistical material properties.** Langland, R.T.; Tokarz, F.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Aug 1975. Contract W-7405-Eng-48. 206p. Dep. NTIS $7.60.

An analytical study of coal mine roof behavior was conducted using a computer model. The extraction method used in the model and in the field was room and pillar mining. Standard engineering property information was used with a computer code developed for the Bureau of Mines to calculate roof sag, convergence, roof bolt load change, and crack formation and growth. These calculations are compared to experimental data collected during a field investigation involving two test sites, one in a development area and one in a production area of a coal mine. (auth)

4539 **Gas well sealing projects portend recovery of coal otherwise lost.** Rennick, G.E.; Pasini, J. III. (Morgantown Energy Resarch Center, WV). *Coal Min. Process.*; 12: No. 11, 52, 54, 68(Nov 1975).

A method has been demonstrated for sealing abandoned and active wells that would reduce substantially the need for leaving huge blocks of coal in the ground for safety when oil and gas wells penetrate coal deposits. This makes possible the deep-mining of millions of tons of bituminous coals that would otherwise be left in the ground. (EJH)

COMBUSTION

4540 (CONF-751106—15) **Flow visualization of a fluidized bed furnace for a coal-fired closed cycle gas turbine.** Holcomb, R.S. (Oak Ridge National Lab., Tenn. (USA)). 1975. 18p. Dep. NTIS $4.50.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

Flow visualization studies were performed on a small-scale Plexiglas model of a coal-burning fluidized-bed furnace that has been designed as a heat source for a closed-cycle gas turbine total energy system for the HUD-MIUS Program. The test model was 10-in. square with a tube bundle of 1/4-in. OD tubes 6 rows deep. The bed material was limestone with a mean particle size of 370 μm and a static bed height of 1 ft. The following results were obtained: a static region of bed material can be used as thermal insulation on the bed plate and around the turbine air manifolds; the minimum velocity for solids mixing at the wall was 1.75 ft/sec, allowing a 3:1 turndown of the furnace; the bed pulsation frequency was 2-3 cycles/sec over the operating range of air velocity. (auth)

4541 (CONF-751106—16) **Instabilities in a coal burning fluidized bed.** Thompson, A.S. (Oak Ridge National Lab., Tenn. (USA)). 1975. Contract W-7405-eng-26. 25p. Dep. NTIS $4.50.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

Equations have been derived, based on a simplified flow model, for the analytical prediction of the frequency at which periodic instabilities are generated in a bed of particulate matter when the bed is fluidized by the circulation of a gas through it. The frequency so derived depends on the inverse square root of the bed depth and on the expansion ratio of the bed in its operating condition. The expansion ratio in turn depends on the velocity of the fluidizing gas. The results of the analysis indicate that, between the minimum and maximum flow rates at which fluidization can exist, there are two bed depths at each flow rate for which the forces on a particle are in equilibrium, one corresponding to a dense phase, the other to a light phase of the particulate matter of which the bed is composed. Only for flow rates below a prescribed maximum are these two phases in quasi stable equilibrium. (auth)

MARKETING AND ECONOMICS

4542 (FE—1552-1(Vol.1)) **Clean coal energy: source-to-use economics, phase II. Annual report for the period July 1974—July 1975.** Nagarvala, P.J.; Ferrell, G.C.; Olver, L.A. (Bechtel Corp., San Francisco, Calif. (USA)). Aug 1975. Contract E(49-18)-1552. 117p. Dep. NTIS $6.00.

The purpose of the project is to evaluate the relative economics and efficiencies of various systems of delivering clean coal energy from the mine to the energy user. Results of the project can assist in maximizing the utilization of the nation's coal resources in the most cost-effective manner consistent with environmental considerations. To maximize cost-effective utilization of coal resources, it is necessary to know the economics and efficiencies of each element of the various alternative systems of delivering energy from the mine mouth to the energy user, and of the economic and physical interrelationships of these elements. Comparisons between the large number of possible system configurations, under changing economic and technological conditions, involves extensive calculations which can be most effectively accomplished by the use of mathematical programming. For this purpose, a regional linear programming model and associated data base for the U.S. coal-energy system have been developed. The model is being used for analyzing actual and proposed or projected coal-energy delivery systems in terms of a number of variables, including quality of coal at the mine, energy transportation or transmission modes, the amount and form of the delivered energy, the distance between mine and user or processor, coal-energy conversion and clean-up processing methods, and existing and proposed environmental regulations. This volume is in seven sections: (1) Introduction and Summary; (2) Energy System Data Base; (3) Linear Programming Cost Model; (4) Phase I Developmental Models; (5) Phase II PAD-Level Model; (6) Phase II Modified-PAD-Level Model; and (7) Future Research and Development Plans. (auth)

4543 (FE—1552-1(Vol.2)) **Clean coal energy: source-to-use economics, phase II. Annual report for the period July 1974—July 1975.** Nagarvala, P.J.; Ferrell, G.C.; Olver, L.A. (Bechtel Corp., San Francisco, Calif. (USA)). Aug 1975. Contract E(49-18)-1552. 150p. Dep. NTIS $7.00.

This volume consists of the appendixes to Vol. 1. Appendix A is a list of 488 references; Appendix B is entitled Linear Programming 1980 M-PAD Data Base Tables and Output Reports. (EJH)

PETROLEUM

4544 (BERC/IC—75-2) **Selected list of Bureau of Mines publications on petroleum and natural gas, 1971—1975.** Hutchison, V.V. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Sep 1975. 105p. Dep. NTIS $5.45.

This selected list contains 394 entries with citations to Bureau of Mines publications related to petroleum and natural gas which were released during the 1971-1975 period. Some entries are multiple in nature, resulting in a total of 424 citations. (auth)

DRILLING AND PRODUCTION

4545 (BERC—75/4) **Contracts and grants for cooperative research on enhancement of recovery of oil and gas. Progress review No. 4.** Linville, B. (ed.). (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Nov 1975. 95p. TIC.

Fifteen contractual research projects and ten grants are listed and discussed individually as to objectives and summary of technical progress, and when appropriate, publications and background information. A glossary is included. (JGB)

BY-PRODUCTS

4546 (BERC/PPS—75/3) **Diesel fuel oils, 1975.** Shelton, E.M. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Nov 1975. 40p. Dep. NTIS $4.00.

Properties of diesel fuels produced during 1975 were submitted for study and compilation under a cooperative agreement between the Energy Research and Development Administration

(ERDA), Bartlesville Energy Research Center (BERC), Bartlesville, Oklahoma and the American Petroleum Institute (API). Tests of 225 samples of diesel fuel oils from 107 refineries throughout the country were made by 31 petroleum refining companies. The analyses of the fuels are listed in tables for four groups according to type of diesel fuel. Each group of analyses is subdivided into five tabulations according to five general regions of the country where the fuels are marketed. The regions, containing a total of 16 districts, are shown on a map in the report. A total of 13 laboratory tests are listed and arranged by geographic marketing districts in decreasing order of sales volumes. Charts are included showing trends of averages of certain properties for the four types of diesel fuels for the years 1960-1975. Summaries of the results of the 1975 survey, compared with similar data for 1974, are shown in tables 1 through 4 of the report. (auth)

MARKETING AND ECONOMICS

4547 (CONF-751214—1) **Econometric model of the petroleum industry.** Rice, P.L.; Smith, V.K. (Oak Ridge National Lab., Tenn. (USA)). 1975. 43p. Dep. NTIS $5.00.

From Meeting of the American Econometric Society; Dallas, Texas, USA (27 Dec 1975).

A model is presented of the petroleum industry, which includes full consideration of the domestic supply of crude and refinery products and their respective demands. A major goal of the model is to provide a broad, flexible approach with a minimum of restrictive assumptions as to the nature of the production function, the scale economies characterizing each sector, and the demand elasticity confronting producers. The underlying structure of the industry is briefly discussed to demonstrate that the proper model should not be tied to a rigid assumption of perfect competition. Previous modeling attempts are reviewed to provide a guideline for the development of the model. Estimates of the 41-equation nonlinear model are then presented and evaluated with conventional goodness-of-fit tests. The model is simulated over the period 1974 to 1985 assuming crude prices are deregulated in 1976 and a windfall profits tax imposed on the industry. The elimination of the oil depletion allowance is taken into account, and the price comparison of these results with other models is made and the relative superiority of the model demonstrated. (auth)

WASTE MANAGEMENT

4548 (BERC/RI—75/11) **Waste lubricating oil research: geographical and seasonal variations in used lubricating oil basestock composition, part 2.** Whisman, M.L.; Cotton, F.O.; Goetzinger, J.W.; Reynolds, J.W. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Dec 1975. 22p. Dep. NTIS $4.00.

Geographical and seasonal variations in the composition of used automobile lubricating oil were evaluated in this second of a four-part study. Ten used oils were analyzed by standard physical and chemical tests to measure contaminant levels, and the same oils were separated by chromatographic procedures to estimate the quantity of probable compound types and the distribution of major structural groups. In addition, five pairs of waste crankcase drainings were obtained from identical sources at five locations within the continental United States at differing times of the year to evaluate compositional variations that can be considered seasonal fluctuations. Based upon the results of this study, there were no apparent systematic or significant variations in either contaminants or hydrocarbon composition attributable to seasonal variations, and the indications are that compositing crankcase drainings at collection points minimize significant variations in composition. The third part of this study will complete the assessment of used lubricating oil compositional variations with the analysis of 10 more used oils giving a total of 30 samples for comparison. (auth)

NATURAL GAS

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

4549 (PNE-RB—70) **Project Rio Blanco reentry drilling and testing of RB-E-01 well. Final report.** (CER Geonuclear Corp., Las Vegas, Nev. (USA)). Oct 1975. 140p. Dep. NTIS $7.00.

Reentry by the RB-E-01 hole was made through the 7-in. emplacement casing. Details of the drilling operations and test results are presented. (TFD)

OIL SHALES AND TAR SANDS

OIL PRODUCTION, RECOVERY, AND REFINING

IN SITU METHODS, TRUE AND MODIFIED

4550 (CONF-750493—1) **Concurrent gasification and retorting of oil shale: a dual energy source.** Burwell, E.L.; Jacobson, I.A. Jr. (Energy Research and Development Administration, Washington, D.C. (USA)). 1975. 8p. Dep. NTIS $4.50.

From Meeting of the Society of Petroleum Engineers of AIME; Denver, Colorado, USA (7 Apr 1975).

The effects of pressure, oil shale grade, oxygen enrichment, and steam injection on the quantity and heating value of offgas from oil shale retorting was studied in the laboratory. Equations were developed which show that large quantities of medium Btu gas can be produced in conjunction with shale oil production. Results also indicate that up to 84 percent of the original organic content can be produced as combustible gases and crude shale oil. Btu distribution in the gas-liquid product mixture is up to 1 to 1. (auth)

4551 (CONF-751101—63) **Outlook and status of in situ oil shale research.** Decora, A.W. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). 1975. 29p. Dep. NTIS $5.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The current status of in-situ and modified in-situ oil shale research is presented. Programs sponsored by ERDA are emphasized. Areas of emphasis in future research are outlined. (JGB)

4552 **Method for establishing communication path in viscous petroleum-containing formations including tar sand deposits for use in oil recovery operations.** Redford, D.A. (to Texaco Exploration Canada Ltd.). US Patent 3,908,762. 30 Sep 1975. Filed date 27 Sep 1973. 10p.

Many oil recovery techniques for viscous oil recovery such as recovery of bitumen from tar sand deposits, including steam injection and in situ combustion, require establishment of a high permeability interwell fluid flow path in the formation. The method of the present invention comprises forming an initial entry zone into the formation by means such as noncondensible gas sweep or hydraulic fracturing and propping, or utilizing high permeability streaks naturally occurring within the formation, and expanding the zone by injecting steam and a noncondensible gas into the gas swept zone, propped fracture zone or high permeability streak. The mixture of steam and noncondensible gas is injected into the formation at a pressure in pounds per square inch not exceeding numerically the overburden thickness in feet, and the steam-noncondensible gas-bitumen mixture is produced either from the same or a remotely located well. The operation may be repeated through several cycles in order to enlarge the flow channel. Suitable noncondensible gases include nitrogen, air, carbon dioxide, flue gas, exhaust gas, methane, natural gas, ethane, propane, butane and mixtures thereof. Saturated or supersaturated steam may be used. (auth)

4553 **Recovery of petroleum from viscous petroleum containing formations including tar sand deposits.** Redford, D.A.; Allen, J.C. (to Texaco Inc.). US Patent 3,913,671. 21 Oct 1975. Filed date 28 Sep 1973. 8p.

Recovery of viscous petroleum is enhanced by contacting viscous petroleum in the formation near the production well which is restricting flow into the well with an aqueous heating fluid such as steam or hot water. Introduction of the aqueous heating fluid on a continuous or intermittent basis is accomplished by providing a separate flow channel for the heating fluid near the production well. Alkaline material such as sodium hydroxide may be incorporated in the aqueous heating fluid. (auth)

4554 **Method for establishing communication path in viscous petroleum-containing formations including tar sands for oil recovery operations.** Allen, J.C.; Redford, D.A. (to Texaco Inc.). US Patent 3,913,672. 21 Oct 1975. Filed date 15 Oct 1973. 10p.

Many oil recovery techniques for viscous oil recovery including steam injection and in-situ combustion require establish-

ment of a high permeability fluid flow path in the formation. The method of the present invention comprises forming an initial entry zone into the formation by means such as hydraulic fracturing and propping, or utilizing high permeability streaks naturally occurring within the formation, and injecting into the propped fracture zone or high permeability streak a solvent for the petroleum contained in the formation, said solvent being saturated with a gas or containing appreciable quantities of gas dissolved therein. The solvent—gas solution is injected into the formation at a pressure up to a value equal in pounds per square inch to the overburden thickness in feet, until the formation in the exposed area has been pressurized to the desired pressure and thereafter terminating injection and producing the gas and solvent—bitumen mixture by solution gas pressure depletion. The operation may be repeated through several cycles in order to enlarge the flow channel, and in the instance of a multi-well throughput operation, adjacent injection and production wells are both treated in a cyclical fashion until communication between injection wells and production wells is established. Suitable solvents include aromatic hydrocarbons such as benzene, toluene, and xylene as well as carbon disulfide. Suitable gases include carbon dioxide, methane, nitrogen and air. (auth)

4555 In situ production of hydrocarbon values from oil shale using H_2S and CO_2. Pelofsky, A.H. (to Cities Service Research and Development Co.). US Patent 3,915,234. 28 Oct 1975. Filed date 28 Aug 1974. 6p.

Kerogen is recovered from oil shale deposits by introducing CO_2 and H_2S in water into the deposits under pressure and then shutting in the deposits to allow the H_2S and CO_2 solutions to dissolve the inorganic matrix material in the deposits. Kerogen is then recovered from the deposits, preferably as a colloidal suspension. (auth)

4556 Oil shale retort flue gas cooling and cleaning. Burton, R.S. III; French, G.B. (to Occidental Petroleum Corp.). US Patent 3,915,498. 28 Oct 1975. Filed date 11 Sep 1974. 4p.

A technique is provided for cooling the flue gas or off gas from the bottom of an in-situ oil shale retort. The gas is collected in a conduit that has a vertical portion through which the gas flows upwardly. It is then withdrawn from the retort through a gas tight bulkhead. Water is sparged downwardly through the vertical portion of the conduit for cooling and cleaning the gas. Means are provided for draining the sparged water into a sump at the bottom of the retort wherein oil and water are collected. Water and oil are separated and the water may be recycled for additional cooling. (auth)

REFINING

4557 Moving bed reactor conversion process for particulate containing hydrocarbons such as shale oil and tar-sands oil. Anderson, R.F. (to Universal Oil Products Co.). US Patent 3,910,834. 7 Oct 1975. Filed date 29 Aug 1972. 10p.

Crude oil petroleum derived from oil shale or tar sands and containing large amounts of highly abrasive particulate matter, such as rock dust or sulfated ash, is hydroprocessed in a dual function moving bed reactor which simultaneously removes particulate matter by the filter action of the catalyst bed. The effluent from the moving bed reactor is then separated and further hydroprocessed in fixed bed reactors with fresh hydrogen added to the heavier hydrocarbon fraction to promote desulfurization. (auth)

PROPERTIES AND COMPOSITION

4558 (SAND—75-0344) **Preliminary studies on the recovery of oil from Chattanooga shale.** Herrell, A.Y.; Arnold, C. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 23p. Dep. NTIS $4.00.

Three exploratory investigations were performed to examine the recovery of oil from the Chattanooga black shale formation. Thermogravimetric data were analyzed to yield an average activation energy of 57.1 kcal/mole for the conversion process; positive deviations from a reaction order of 3.7 were observed suggesting the presence of autocatalytic effects at low conversion levels. Thermal chromatographic analysis indicated that the maximum organic product release occurred at approximately 435°C and resulted in an oil of relatively low distillation range. A packed bed of shale was retorted in the self-sustained combustion mode thus suggesting the feasibility of this mode for in situ oil recovery. Comparisons with oil shale from Colorado' Green River formation were made. (auth)

4559 (UCID—16938) **Decomposition of carbonate minerals in spent oil shale.** Sohn, H.Y.; Braun, R.L.; Snider, G.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Oct 1975. Contract W-7405-Eng-48. 27p. Dep. NTIS $5.00.

Cylindrical samples of spent shale, ranging in weight from 0.79 to 33.6 g, were heated to temperatures of 685, 850, or 950°C. The spent shale contained 13 to 16 wt percent CO_2 as dolomite (ankerite). In each experiment the weight loss was recorded as a function of time until the sample reached approximately constant weight. The final weight loss and the chemcial analyses before and after the thermal treatment showed that virtually all CO_2 contained in dolomite is liberated during the heating of spent shale at these temperatures. The decomposition rate of dolomite can adequately be treated with a global, first-order kinetics. The rate of dolomite decomposition in a block of spent shale can be predicted with reasonable confidence by properly accounting for intrinsic kinetics and heat transport effects. (auth)

4560 Thermal characteristics of analcime and its effect on heat requirements for oil-shale retorting. Johnson, D.R.; Young, N.B.; Robb, W.A. (Laramie Energy Research Center, WY). *Fuel*; 54: No. 4, 249-252(Oct 1975).

Thermal characteristics of analcime were determined over the temperature range from 25 to 600°C. Loss of water of crystallization from analcime between 175 and 375°C, an endothermic decomposition, could increase the energy required to produce oil from oil shale by a maximum of about six percent. Analcime's widespread distribution through the Green River Formation ensures that analcime will be among the oil-shale components processed in any oil-shale development. (auth)

FISSION FUELS

RESERVES

4561 (COO—3462-12) **Fission-track study of the uranium bio-geochemistry in carbonates of Bikini and Enewetak Atolls. Progress report, July 1, 1974—December 31, 1975.** Levy, Y.; Miller, D.S.; Friedman, G.M.; Goter, E.R. (Rensselaer Polytechnic Inst., Troy, N.Y. (USA). Dept. of Geology). Sep 1975. Contract E(11-1)-3462. 35p. Dep. NTIS $5.00.

Major contributions during this contract period have been in developing an analytical procedure for Pu measurement, and in applying the developed procedures to determining the plutonium concentration and distribution in coral from the Bikini Atoll. In conjunction with these contributions, measurements using the fission-track method have been made of the uranium distribution and concentrations in several carbonate samples from drill cores obtained from the Runit Island Enewetak Atoll. Petrographic studies on these drill core samples have been made to correlate the uranium data with the mineralogical data. (auth)

FEED PROCESSING

4562 Fluidized reactor reduction of UF_6 to UO_2. Welty, R.K. (to Exxon Nuclear Company, Inc.). US Patent 3,906,081. 16 Sep 1975. Filed date 31 May 1973. 4p.

A two stage fluid bed process for converting UF_6 to UO_2 is described. In the first stage UF_6 is converted, preferably in two separate fluid beds, to U_3O_8 by first forming UO_2F_2 solids and treating the UO_2F_2 with steam to produce U_3O_8. The U_3O_8 is reduced at relatively low temperatures i.e., at about 450°C to about 500°C., in a second stage to uranium dioxide. (auth)

ENRICHMENT

GASEOUS DIFFUSION

4563 (CONF-750324—7) **Uranium enrichment in the United States.** Hill, J.H.; Parks, J.W. (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Oak Ridge Operations Office). 1975. 22p. Dep. NTIS $4.50.

From International conference on uranium isotope separation; London, UK (5 Mar 1975).

History, improvement programs, status of electrical power availability, demands for uranium enrichment, operating plan for the U. S. enriching facilities, working inventory of enriched uranium, possible factors affecting deviations in the operating plan, status of gaseous diffusion technology, status of U. S. gas cen-

trifuge advances, transfer of enrichment technology, gaseous diffusion—gas centrifuge comparison, new enrichment capacity, U. S. separative work pricing, and investment in nuclear energy are discussed. (LK)

4564 (CONF-750735—) **Uranium enrichment conference on modified contract option, Oak Ridge, Tennessee, July 22, 1975.** (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). 1975. 50p. Dep. NTIS $4.00.

From Uranium enrichment conference on modified contract option; Oak Ridge, Tennessee, USA (22 Jul 1975).

The questions and answers presented in this document originated at an industry-wide meeting sponsored by the Energy Research and Development Administration held in Oak Ridge, Tennessee, on July 22, 1975, to discuss features and provisions of an ERDA plan to adjust contracts held by firms receiving uranium enriching services from ERDA. On June 19, 1975, ERDA announced terms of an expanded contract modification plan. The modified contract option broadened a previous plan proposed on January 15, 1975, by the former Atomic Energy Commission. The meeting in Oak Ridge on July 22, 1975, was designed to provide additional information on the expanded contract option and to offer ample opportunity for questions and answers prior to August 18, 1975, by which time enriching services customers who chose the one-time option had to so notify ERDA. The meeting included presentations by officials of ERDA Headquarters and ERDA's Oak Ridge Operations on the features of the contract adjustment offer, including provisions for contract termination in whole, separative work schedule adjustments, and uranium feed delivery schedule relaxation. (auth)

4565 (K-L—6353) **Enrichment: the current status at Oak Ridge, Portsmouth, and Paducah.** Wilcox, W.J. Jr.; Bradbury, J.T. (Oak Ridge Y-12 Plant, Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 29p. (CONF-751101—52). Dep. NTIS $5.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Expansion of the diffusion plants is discussed in detail. Other enrichment processes, particularly the gas centrifuge process, are mentioned briefly. (LK)

LASER EXCITATION

4566 (COO—3581-3) **Stable isotope studies. Progress report, August 1, 1974—July 31, 1975.** Flynn, G.W.; Hsu, D.S.Y.; Preses, J.M.; Spindel, W.; Weston, R.E. (Yeshiva Univ., New York (USA). Belfer Graduate School of Science). 31 Jul 1975. Contract AT(11-1)-3581. 37p. Dep. NTIS $5.00.

Progress is reported in the following studies: selective two-step laser-induced photodissociation, unimolecular processes induced by multiple-photon absorption, and vibrational energy transfer processes involving isotopic species of sulfur dioxide. These laser-induced chemical reactions can possibly be applied to isotope separation. (LK)

FUELS PRODUCTION AND PROPERTIES

4567 (HEDL-TME—75-91) **Reaction of SiO_2 and Al_2O_3 with (U, Pu)O_2.** Gibby, R.L.; Clark, W.I. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jun 1975. Contract AT(45-1)-2170. 19p. AT.

High temperature reactions of Al_2O_3 and SiO_2 with PuO_2 and UO_2—25 wt percent PuO_2 were investigated under conditions of temperature and oxygen activity similar to what could be encountered in a typical oxide fuel pellet sintering process. Several reaction products were identified and characterized by x-ray diffraction and electron microprobe analyses. The results were used to help identify and characterize local impurity concentrations which have been observed on sintered FTR-type fuel pellets. (auth)

4568 (LA—6083-T) **Oxygen potential of uranium—plutonium oxide as determined by controlled-atmosphere thermogravimetry.** Swanson, G.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-ENG-36. 130p. Dep. NTIS $5.45.

Thesis.

The oxygen-to-metal atom ratio, or O/M, of solid solution uranium-plutonium oxide reactor fuel is a measure of the concentration of crystal defects in the oxide which affect many fuel properties, particularly, fuel oxygen potential. Fabrication of a high-temperature oxygen electrode, employing an electro-active tip of oxygen-deficient solid-state electrolyte, intended to confirm gaseous oxygen potentials is described. Uranium oxide and plutonium oxide O/M reference materials were prepared by in situ oxidation of high purity metals in the thermobalance. A solid solution uranium-plutonium oxide O/M reference material was prepared by alloying the uranium and plutonium metals in a yttrium oxide crucible at 1200°C and oxidizing with moist He at 250°C. The individual and solid solution oxides were isothermally equilibrated with controlled oxygen potentials between 800 and 1300°C and the equilibrated O/M ratios calculated with corrections for impurities and buoyancy effects. Use of a reference oxygen potential of -100 kcal/mol to produce an O/M of 2.000 is confirmed by these results. However, because of the lengthy equilibration times required for all oxides, use of the O/M reference materials rather than a reference oxygen potential is recommended for O/M analysis methods calibrations. (auth)

4569 (ORNL—5050, pp 25-26) **Preparation of $^{233}UO_2$.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

Recovery of ^{233}U from waste UO_2 and scrap UO_2—ThO_2 pellets, ^{233}U purification systems, and conversion of ^{233}U from nitrate solution to ceramic-grade dioxide powder are discussed. (LK)

4570 (ORNL-TM—1200) **Fuels and materials development program quarterly progress report for period ending June 30, 1965.** Patriarca, P. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Sep 1965. Contract W-7405-eng-26. 83p. Dep. NTIS $6.00.

Activities in research programs are reported on fuel element development, mechanical properties of heat resisting alloys, nondestructive testing, zirconium metallurgy, nuclear ceramics, and radiation effects on fuel materials. (JRD)

SPENT FUELS REPROCESSING

4571 (ARH—1514) **Criticality prevention specifications thorium—uranium-233 separations in the Purex Plant.** Matheison, W.E.; Oberg, G.C.; Ritter, G.L. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 1 Jun 1970. Contract AT(45-1)-2130. 51p. Dep. NTIS $5.50.

The specifications in this document define the limits or restrictions required to maintain an acceptably low probability of the occurrence of a nuclear chain reaction in the Purex Plant while processing irradiated thoria targets. These criticality prevention specifications do not stipulate the system, procedures, or mechanisms to permit operation within the limits or restrictions. (LK)

4572 (ARH—1748) **Purex Plant chemical flowsheet for the 1970 thorium campaign.** Smith, G.F. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 10 Jul 1970. Contract AT(45-1)-2130. 56p. Dep. NTIS $5.50.

The chemical flowsheets recommended for the 1970 thorium campaign are presented and are basically the same as those used for the 1966 campaign. (LK)

4573 (ARH—1757) **Process specifications and standards for the 1970 thorium campaign in the Purex Plant.** Van der Cook, R.E.; Ritter, G.L. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 30 Jun 1970. Contract AT(45-1)-2130. 31p. Dep. NTIS $5.00.

The process specifications and standards for thorium processing operations in the Purex Plant are presented. These specifications represent currently known limits within which plant processing conditions must be maintained to meet defined product requirements safely and with minimum effect on equipment service life. These specifications cover the general areas of feed, essential materials, and chemical hazards. (LK)

4574 (ARH—1774) **Quality control program, Purex thoria processing.** Nicholson, G.A. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 10 Aug 1970. Contract AT(45-1)-2130. 27p. Dep. NTIS $5.00.

The quality control activities associated with the production of ^{233}U by separation from irradiated thoria and other radioactive contaminants are described. (LK)

4575 (ARH—1775) **Process control guidelines for CY 70 thorium campaign.** Jackson, R.R. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 29 Jul 1970. Contract AT(45-1)-2130. 63p. Dep. NTIS $5.50.

The report comprises five parts, with part I being an introduction. Part II consists of a general treatment of process control methods. Parts III through V discuss, in the flowsheet sequence, those problems pertinent to each equipment piece or

system and provide operating guidelines. Specific operations that are somewhat different from those normally encountered in Purex are discussed at length. Operations routine to Purex can be found in the pertinent standard operating procedures. Part VI describes in general terms the sequence to be followed in initiating and completing a variety of transient conditions. (LK)

4576 (CONF-750515—4) **Idaho Chemical Processing Plant training program.** (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs - Operations Office). 1975. 21p. Dep. NTIS $4.50.

From 2. ANS symposium on training of nuclear facility personnel; Gatlinburg, Tennessee, USA (11 May 1975).

Objectives, regulations and requirements, training methods, certification and recertification, progression and incentives, and coverage of the ICPP operator training program are discussed in detail. (LK)

4577 (DOCKET-50332—52) **Barnwell Nuclear Fuel Plant. License application, FSAR, amendment 6.** (Allied-Gulf Nuclear Services, Barnwell, S.C. (USA)). Aug 1975. 458p. Dep. NTIS $26.00.

FSAR Amendment No. 6 consists principally of revisions of the portions relating to: (1) facilities for the interim storage of solid waste, (2) handling of spent iodine scrubber solutions, and (3) the rise of N_2O_4 as an oxidizer. (LK)

4578 (DP—638) **Neptunium behavior in solvent extraction of uranium at Savannah River Plant.** Henry, H.E.; Karraker, D.G.; Schlea, C.S. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Sep 1961. Contract AT(07-2)-1. 27p. Dep. NTIS $4.50.

Declassified 23 Apr 1973.

The solvent extraction behavior of neptunium in the processing of irradiated natural uranium (Purex process) and irradiated enriched uranium (HM process) at Savannah River was studied in the laboratory. Conditions were demonstrated for extracting neptunium in the first solvent extraction contactor of each process, and two methods were developed for partitioning neptunium from uranium in the HM process. (auth)

4579 (ISO—419) **Thorium process operation report.** (Isochem Inc., Richland, Wash. (USA)). Dec 1967. Contract AT(45-1)-1851. 142p. Dep. NTIS $7.00.

Declassified 3 Aug 1973.

Preparation for the Purex thorium campaign began on April 15, 1966 when the plant was cleaned out and stripped from uranium processing. Flushing and equipment changes involved in the turnaround for thorium processing were completed on May 11, 1966, when irradiated thoria was first introduced to the plant dissolvers. The last of the thoria was charged to the dissolvers on July 2, 1966, and product stripping operations were completed on July 10, 1966. Plant flushing and equipment changes associated with reconversion of the plant to uranium processing were completed by August 20, 1966. One hundred ninety-four tons of thoria was processed during the campaign; the product, thorium nitrate solution, was transferred to the WR Vault for temporary storage. Two hundred twenty-three kilograms of ^{233}U were recovered during the campaign. One hundred twenty kilograms have been delivered to the Nuclear Fuels Services facility in Erwin, Tennessee; the remainder has been shipped to Oak Ridge. At the start of the campaign, 3.4 tons of thorium nitrate product from the thorium test run were reworked to meet specifications. Tight specifications for both thorium and ^{233}U products were met during the campaign. The quality of the ^{233}U product exceeded target specifications in almost every area. Recovery of thorium and ^{233}U were 97 percent and 94 percent, respectively. The overall material balance on the two products was within 1.2 percent and 2.3 percent, respectively. (auth)

4580 (ORNL-TM—5123) **Modifications of the SEPHIS computer code for calculating the Purex solvent extraction system.** Watson, S.B.; Rainey, R.H. (Oak Ridge National Lab., Tenn. (USA)). Dec 1975. Contract W-7405-eng-26. 59p. Dep. NTIS $5.45.

The SEPHIS computer program was developed to simulate the countercurrent solvent extraction. This report gives modifications in the program which result in improved fit to experimental data, a decrease in computer storage requirements, and a decrease in execution time. Methods for applying the computer program to practical solvent extraction problems are explained. (auth)

4581 (UCRL—77395) **Generation of floor response spectra for mixed-oxide fuel fabrication plants.** Arthur, D.F.; Murray, R.C.; Tokarz, F.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Oct 1975. 20p. (CONF-751204—2). Dep. NTIS $4.50.

From ASCE specialty conference; New Orleans, Louisiana, USA (8 Dec 1975).

Floor or amplified response spectra are generally used as input motion for seismic analysis of critical equipment and piping in nuclear power plants and related facilities. The floor spectra are normally the result of a time-history calculation of building response to ground shaking. However, alternate approximate methods have been suggested by both Kapur and Biggs. As part of a study for the Nuclear Regulatory Commission horizontal floor response spectra were generated and compared by all three methods. The dynamic analyses were performed on a model of the Westinghouse Recycle Fuels Plant Manufacturing Building (MOFFP). Input to the time-history calculations was a synthesized accelerogram whose response spectrum is similar to that in Regulatory Guide 1.60. The response spectrum of the synthetic ground motion was used as input to the Kapur and Biggs methods. Calculations were performed for both hard (3500 fps) and soft (1500 fps) foundation soils. Results of comparison of the three methods indicate that although the approximate methods could easily be made acceptable from a safety standpoint, they would be overly conservative. The time-history method will yield floor spectra which are less uncertain and less conservative for a relatively modest additional effort. (auth)

WASTE MANAGEMENT

WASTE PROCESSING

4582 (ANL—73-43) **Chemical Engineering Division waste management programs. Quarterly report, January—March 1975.** Steindler, M.J.; Levitz, N.M.; Mecham, W.J.; Seefeldt, W.B.; Trevorrow, L.E.; Winsch, I.O.; Cannon, T.F.; Gerding, T.J.; Kullen, B.J.; Webster, D.S.; Burris, L. (Argonne National Lab., Ill. (USA)). Jun 1975. Contract W-31-109-Eng-38. 93p. Dep. NTIS $5.45.

Development work on the study of consolidation techniques for Zircaloy fuel-cladding hulls included scouting tests on volatility schemes for separating the zirconium as the volatile tetrachloride and ignition tests on several Zircaloy materials to further characterize the pyrophoric behavior of Zircaloy. All tests were with nonirradiated metal pending acquisition of irradiated samples. Installation is nearly complete of a glovebox facility for studies on the salvage of alpha-contaminated metals by pyrochemical methods. Disposal of a major portion of fission product tritium formed in light water reactor fuels by deep-well injection of the low-level aqueous waste from plants reprocessing such fuels is being evaluated. The question of siting is a very important factor in determining the feasibility of this particular disposal option. A review is given of the status of information for U. S. sedimentary basins, the areas most likely to be generally suitable for siting of waste wells. Work on the reliability of high-level-waste canisters included an examination of creep, shot-peening, and subcooling of the filler canister below storage temperatures, as methods of relieving stresses induced in canisters due to differential contraction of canister and glass during cooling. A method was investigated for relieving stresses in calcine-filled canisters. Properties of fission product oxides were examined to elucidate possible adverse corrosive effects at the canister-waste interface. (LK)

4583 (ARH-LD—108) **Calcine Conversion Facility alternative concepts engineering studies.** (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Feb 1975. Contract AT(45-1)-2130. 77p. Dep. NTIS $6.00.

The purpose of the engineering study reported is to develop conceptual designs for two alternative facilities for the conversion of high level waste calcine to high level glass. The objectives and design bases of the two concepts (CCF/RSSF and CCF/FRP) are described. No recommendation of one concept in preference to the other is given. (LK)

4584 (BNWL—1936) **Nuclear Waste Management and Transportation quarterly progress report, April—June 1975.** Platt, A.M. (comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-1830. 75p. Dep. NTIS $5.45.

Research progress is reported on all Division of Waste Management and transportation funded programs at Battelle, Pacific Northwest Laboratories, with the exception of the Commercial Radioactive Waste Fixation Program. Topics reported on include advanced methods for management and disposal of radioactive wastes; separation of actinide elements from radioactive waste; decontamination and densification of chop-leach cladding residues; pyrolysis-incineration of combustible alpha wastes, tritium separation and fixation; characterization of 300 and WYE burial grounds; disposition of retired, contaminated facilities at Hanford; development of packaging technology for $Pu(NO_3)_4$ shipment; and transportation safety studies. (LK)

4585 (DP—1371) **Dissolution of PuO_2 with cerium(IV) and fluoride promoters.** Harmon, H.D. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Oct 1975. Contract AT(07-2)-1. 31p. Dep. NTIS $4.00.

Ce(IV) in low concentrations is an effective promoter of PuO_2 dissolution in nitric acid solutions of approximately 3 to 6M. However, stoichiometric quantities of Ce(IV) are required for complete dissolution, and hydrothermal precipitation of CeO_2 is a potential problem at low acidities. Dissolution proceeds with oxidation of Pu(IV) to Pu(VI) with a corresponding reduction of Ce(IV). When an excess of Ce(IV) is present, the dissolution rate depends on Ce(IV) concentration below approximately 0.1M Ce(IV); above this concentration, the rate becomes fairly constant. Increased PuO_2 sintering temperature markedly reduces the dissolution rate in 4M HNO_3-0.15M Ce(IV). Preliminary results indicate stainless steel corrosion rates in Ce(IV)-HNO_3 solutions increase to significant values with increasing Ce(IV) concentration. In HNO_3-KF, the PuO_2 dissolution rate increases rapidly as the nitric acid and fluoride concentrations increase. The rate is decreased by increased PuO_2 sintering temperature and the presence of cationic species such as UO_2^{2+} and Fe^{3+}, which complex fluoride. Dissolution is much more rapid in HNO_3-KF solutions than in HNO_3-Ce(IV). Mixed KF and Ce(IV) in certain mole ratios in 8M HNO_3 gives more rapid dissolution than with Ce(IV) or KF alone; more Ce(IV) retards dissolution. In HNO_3-0.05M Ce(IV)—0.1M KF, the dissolution rate increases as HNO_3 concentration increases; below 6M HNO_3, the mixed system containing 0.05M Ce(IV)-0.1M KF is less effective than HNO_3-Ce(IV) or HNO_3-KF. Ruthenium, present in irradiated PuO_2, catalytically reduces Ce(IV) in nitric acid; thus, Ce(IV) will be ineffective for irradiated PuO_2-UO_2 fuel. In view of the ruthenium problem, HNO_3-F^- solutions appear most promising for breeder fuel processing. Nitric acid solutions containing Ce(IV) and Ce(IV)-F^- mixtures may be most useful for dissolving unirradiated PuO_2 and UO_2-PuO_2 materials, as in scrap recovery operations. (auth)

4586 (DP—1383) **Evaluation of fluoride, cerium(IV), and cerium(IV)—fluoride mixtures as dissolution promoters for PuO_2 scrap recovery processes.** Harmon, H.D. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Oct 1975. Contract AT(07-2)-1. 18p. Dep. NTIS $4.00.

Fluoride, cerium(IV), and cerium(IV)-fluoride mixtures were evaluated as promoters for nitric acid dissolution of unirradiated PuO_2 scrap. Fluoride was most effective in promoting rapid and complete dissolution of 80 to 160 g of PuO_2/liter of dissolvent. Cerium(IV) was unsuitable at the high PuO_2/dissolvent ratios normally used in scrap processing because high Ce(IV) concentrations or a Ce(IV) regeneration process were required. Mixing Ce(IV) and fluoride at a ratio of 4 KF/Ce(IV) in 8M HNO_3 increased the PuO_2 dissolution rate at PuO_2 concentrations of less than 10 g/liter, but not at the desired high PuO_2/dissolvent ratios. The dissolution rate of PuO_2 scrap in HNO_3-F^- and HNO_3-Ce(IV) solutions was related inversely to the temperature of the PuO_2 fabrication process. (auth)

4587 (DP—1397) **Evaluation of glass as a matrix for solidification of Savannah River Plant waste.** Kelley, J.A. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Oct 1975. 21p. Dep. NTIS $4;00.

Laboratory tests using actual sludges collected from Savannah River Plant (SRP) waste tanks were performed to evaluate glass as a waste solidification matrix. Sludge was collected from three SRP waste tanks, washed to remove soluble salts, and then ground to a fine powder. From 25 to 40 wt percent of these sludges was vitrified into a borosilicate glass by melting at 1150°C. Substitution of 4 wt percent Li_2O for 4 wt percent Na_2O in the glass mix allowed higher loading of a high-aluminum sludge. No problems with phase separation were encountered, and all sludge components, except mercury which volatilized, appeared to dissolve completely in the glass melt. Volatilization of radionuclides during melting was 0.3 percent for ^{137}Cs, 2.9 percent for ^{106}Ru, and less than or equal to 0.01 percent for other nuclides. Initial leachabilities of glass products were low: 10^{-6} to 10^{-5} g/(cm²-day) for ^{137}, ^{90}Sr, and alpha activity. Leachabilities decreased to 10^{-8} to 10^{-7} g/(cm²- day) in approximately 2 weeks. Heating the glasses at 600°C for 1 month caused devitrification which increased leachability, but durable waste forms still remained. This work showed that vitrification of SRP high-level waste sludges in borosilicate glass is feasible. Further investigation of melting concepts, scale-up, cost, long-term stability, and other factors are planned as a part of the development program for long-term waste management. (auth)

4588 (DP-MS—75-17) **Concentration of aqueous radioactive waste with wiped-film evaporators.** Goodlett, C.B. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 38p. (CONF-751107—2). Dep. NTIS $5.00.

From 68. annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

Tests at the Savannah River Laboratory with two small wiped-film evaporators show that synthetic alkaline (Purex) waste can be converted to a free-flowing slurry that solidifies on cooling to ambient temperature. The desired concentration can be obtained in one pass rather than the several passes required with the bent-tube evaporators presently used at the Savannah River Plant. (auth)

4589 (DP-MS—75-19) **Solidification and storage of Savannah River Plant radioactive waste.** Kelley, J.A.; Hale, W.H.; Stone, J.A.; Wiley, J.R. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 17p. (CONF-751107—5). Dep. NTIS $4.00.

From 68. annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

A conceptual process for solidification of SRP aqueous waste into high-integrity, low-leachable forms was developed. The process separates about 99.9 percent of the biological hazard from approximately 97 percent of the waste. The major biological hazard remaining in the residual salt is ^{106}Ru, which has a 369-day half-life. Sludge and zeolite can be solidified into concrete or glass. Cost-risk analyses are being made to determine which of these forms is preferred for SRP waste. Also, studies on other parts of the conceptual process are in progress. (auth)

4590 (DPST—75-452) **Theoretical aspects of solid waste incineration.** Tarbell, J.M. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 24p. Dep. NTIS $4.50.

Theoretical considerations that may be incorporated into the design basis of a prototype incinerator for solid transuranic wastes are described. It is concluded that primary pyrolysis followed by secondary afterburning is a very unattractive incineration strategy unless waste resource recovery is a process goal. The absence of primary combustion air leads to poor waste dispersion with associated diffusion and conduction limitations rendering the process inefficient. Single step oxidative incineration is most attractive when volume reduction is of primary importance. The volume of this type of incinerator (including afterburner) should be relatively much smaller than the pyrolysis type. Afterburning is limited by soot oxidation when preceded by pyrolysis, but limited by turbulent mixing when preceded by direct solid waste oxidation. In either case, afterburner temperatures above 1300°K are not warranted. Results based on a nominal solid waste composition and anticipated throughput indicate that NO/sub x/, HF, and SO_2, will not exceed the ambient air quality standards. Control of radioactive particulates, which can be achieved by multiple HEPA filtration, will reduce the conventional particulate emission to the vanishing point. Chemical equilibrium calculations also indicate that chlorine and to a lesser extent fluorine may be precipitated out in the ash as sodium salts if a sufficient flux of sodium is introduced into the incinerator. (auth)

4591 (MLM—2270) **Tritium effluent control project. Progress report, April—June 1975.** Kershner, C.J.; Bixel, J.C. (Mound Lab., Miamisburg, Ohio (USA)). 17 Nov 1975. Contract E-33-1-GEN-53. 13p. Dep. NTIS $4.00.

In the tritiated liquid waste decontamination program, the major effort was directed toward procurement of the equipment needed to perform feasibility experiments on water detritiation. The catalytic water detritiation system was fabricated and helium leak tested by Engelhard Minerals and Chemicals Corporation. The system was received at Mound and will be installed in the Tritium Effluent Control Development Laboratory. (LK)

4592 (ORNL—5050, pp 27-35) **Separations chemistry research and development.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

Acylated pyrazolones in mixture with donor additions, such as TOPO and TBP, were examined as selective extractants for plutonium and the transplutonium actenides from acidic reprocessing waste solutions. Bifunctional phosphonates have potential applicability to separating americium, curium, and rare earths from all of the other fission products in fuel reprocessing wastes without prior destruction of the HNO_3. In the project to investigate the leaching characteristics of radium from uranium ores and sulfate-leached ore tailings, a study was made of the interrelation of the effective solubilities of calcium, strontium, barium, and radium sulfates. An improved flowsheet was devised for removal of americium and curium from reprocessing wastes. Since plutonium will be recovered from spent reactor fuels by the Purex, in which Pu(IV) is extracted into TBP from HNO_3 feed solution, experiments were designed to determine the stability of Pu(IV) in HNO_3 and in synthetic fission product solutions at various temperatures and acidities of interest.

A study of the kinetics of the reduction of Np(VI) to Np(IV) in nitric acid solution by ferrous nitrate was made using spectrophotometric methods. (LK)

4593 (ORNL—5050, pp 82-85) **Iodine studies.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

A remote possibility exists that charcoal adsorbers in nuclear reactor installations would be required to retain larger quantities of radioactive iodine than normally adsorbed if certain postulated accidents occurred. An experimental program is being conducted to determine the effects that such loading would have on the retention of iodine (^{129}I used in study) and whether the resulting decay heat would ultimately lead to ignition of the charcoal. A study of the reaction of organic iodides with hyperazeotropropic nitric acid is oriented toward the planned LMFBR processing scheme, which includes the removal of iodine by 20 M HNO_3 (Iodox process). (LK)

4594 (SAND—75-5601) **Ceramics from ion exchangers: an approach to nuclear waste solidification.** Dosch, R.G. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 3p. (CONF-751101—37). Dep. NTIS $4.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

A waste solidification process involving inorganic ion exchange materials under development was tested on both simulated and actual high level waste streams. The process is based on a recently developed group of titanate, niobate, and zirconate inorganic ion exchange materials. After reaction with the waste stream, these materials can be consolidated and fired to form stable, ceramic solid waste forms. Decontamination factors of greater than or equal to 10^8 were obtained for cationic radionuclides and a tail-end anion exchange step lowered the activity in the process effluent to 0.1 to 1 μCi/ml, primarily attributable to ^{106}Ru. The solid waste (fully consolidated titanate form) generated by the process has a density of 4.6 g/cm^3 and a concentration factor of 1.1 g of waste oxides per cubic centimeter. The leaching and volatility characteristics of the solid are comparable to those observed for borosilicate glass waste forms. (JGB)

4595 (Y—1990) **Denitrification of acid wastes from uranium purification processes.** Clark, F.E.; Francis, C.W.; Francke, H.C.; Strohecker, J.W. (Oak Ridge Y-12 Plant, Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 78p. Dep. NTIS $5.45.

Laboratory and pilot-plant investigations have shown the technical feasibility of removing nitrates from neutralized acid wastes from uranium purification processes by biological denitrification, a dissimilatory process in which the nitrate ion is reduced to nitrogen gas by specific bacteria. The process requires anaerobic conditions and an organic carbon source, as well as other life-sustaining constituents. These denitrification studies produced process design information on a columnar denitrification plant and on continuous-flow, stirred-bed reactors. Denitrification, using packed columns, was found to be desirable for soluble salts, such as those of sodium and ammonium; denitrification, using stirred reactors, was found to be desirable for mixtures containing insoluble salts, such as those of calcium and aluminum. Packed columns were found to have denitrification rates ranging up to 122 grams of nitrate per day per cubic decimeter of column volume; stirred-bed reactors have been shown to have reaction rates near 10 grams of nitrate per day per cubic decimeter of reactor volume. The continuous-flow, stirred-bed reactors were selected for scaleup studies because of the solids-removal problems associated with packed columns when operating on feeds containing high concentrations of insoluble salts or ions which form insoluble salts with the products of the denitrification reaction. (auth)

WASTE DISPOSAL AND STORAGE

4596 (ARH-CD—133A) **Operations Division waste status summary, January 1, 1974—March 31, 1974.** Anderson, J.D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 31 Jul 1974. Contract AT(45-1)-2130. 12p. Dep. NTIS $4.00.

4597 (ARH-CD—133B) **Operations Division waste status summary. Progress report, 1 April 1974—30 June 1974.** Anderson, J.D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 12 Aug 1974. 13p. Dep. NTIS $4.00.

4598 (ARH-CD—133D) **Production and Waste Management Division waste status summary, October 1, 1974—December 31, 1974.** Anderson, J.D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 30 Jan 1975. Contract AT(45-1)-2130. 12p. Dep. NTIS $4.00.

4599 (ARH-SA—221) **Conceptual design considerations for the storage of solidified high-level waste in canisters at a commercial fuel reprocessing plant.** LaRiviere, J.R.; Moore, E.L. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Nov 1975. Contract E(45-1)-2130. 19p. (CONF-751107—3). Dep. NTIS $4.00.

From 68. annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

Onsite storage of canisters of solidified high-level waste generated by the commercial fuel reprocessing plants (FRP) may be required prior to shipping these canisters to a Federal repository. The most likely storage concept is to hold the waste-filled canisters in water storage basins. In the Retrievable Surface Storage Facility conceptual design studies, air-cooled and water-cooled storage of solidified high-level wastes has been considered. The studies of water-cooled storage included design considerations, as part of the conceptual design of the canisters and water storage basins, that would apply also to the conceptual design of similar facilities at an FRP. These similar considerations include: types of corrosion likely to develop on canisters stored in water, conditions that promote stress corrosion cracking (SCC), prevention of SCC, routine basin water cleanup, cleanup of a grossly contaminated water basin, effluent discharge discussions, storage basin integrity, and designing for decommissioning. (auth)

4600 (ARH-SA—232) **Characterization of actinide-bearing sediments underlying liquid waste disposal facilities at Hanford.** Price, S.M.; Ames, L.L. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-2130. 23p. (CONF-751105—18; SM—199/87). Dep. NTIS $4.50.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

Past liquid waste disposal practices at the U. S. Energy Research and Development Administration's Hanford Reservation have included the discharges of solutions containing trace quantities of actinides directly into the ground via structures collectively termed "trenches". Characterization of samples from two of these trenches, the 216-Z-9 and the 216-Z-1A(a), has been initiated to determine the present form and migration potential of plutonium stored in sediments which received high salt, acidic waste liquids. Analysis of samples acquired by drilling has revealed that the greatest measured concentration of Pu, approximately 10^6 μCi ^{239}Pu/liter of sediment, occurs in both facilities just below the points of release of the waste liquids. This concentration decreases to approximately 10^3 μCi ^{239}Pu/liter of sediment within the first 2 meters of the underlying sediment columns and to approximately 10 μCi ^{239}Pu/liter of sediment at the maximum depth sampled (9 meters). Examination of relatively undisturbed sediment cores illustrated two types of Pu occurrence responsible for this distribution. One of these types is composed of Pu particles (greater than 70 wt percent PuO_2) added to the disposal site in the same form. This "particulate" type was "filtered out" within the upper 1 meter of the sediment column, accounting for the high concentration of Pu/liter of sediment in this region. The second type of Pu (less than 0.5 wt percent PuO_2) was originally disposed of as soluble Pu(IV). This "nonparticulate" type penetrated deeper within the sediment profile and was deposited in association with silicate hydrolysis of the sediment fragments. (auth)

4601 (ARH-ST—110D) **Atlantic Richfield Hanford Company waste management and transportation technology development. Quarterly report, April 1975—June 1975.** Lyon, R.Y. (ed.). (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-2130. 47p. Dep. NTIS $3.75.

The specific topics discussed are grouped into the subject areas of: (1) Storage System Integrity and Engineered Improvements, (2) Waste Retrieval, (3) Waste Immobilization and Storage, and (4) Contaminated Equipment Volume Reduction. (auth)

4602 (BNWL-B—430) **Polymeric media for tritium fixation.** Franz, J.A.; Burger, L.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 15 May 1975. Contract E(45-1)-1830. 28p. Dep. NTIS $5.45.

The synthesis and leach testing of several polymeric media for tritium fixation are presented. Tritiated bakelite, poly(acrylonitrile) and polystyrene successfully fixed tritium. Tritium leach rates at the tracer level appear to be negligible. Advantages and disadvantages of the processes are discussed, and further bench-scale investigations underway are reported. Rough cost estimates are presented for the different media and are compared with alternate approaches such as deep-well injection and long-term tank storage. Polymeric media costs are high compared to deep-well storage and are of the same order of magnitude per liter of water as for isotopic enrichment. With this limitation, polymeric media can be economically feasible only for highly concentrated tritiated wastes. It is recommended that the bakelite and polystyrene processes be examined on a larger scale to permit more accurate cost analysis and process design. (auth)

4603 (COO—2689-1) **Results of R/V Yaquina cruise YALOC-74, Leg 3: seabed disposal program, North Pacific study area MPG-2, 33°20'N, 151°00'W, November 30—December 21, 1974.** Heath, G.R. (Rhode Island Univ., Kingston (USA). Graduate School of Oceanography). Jul 1975. Contract E(11-1)-2689. 31p. Dep. NTIS $5.00.

During 10 days in the vicinity of 33°20'N, 151°00'W (MPG-2 area), three near-bottom current meters were deployed, the bathymetry and subbottom acoustic structure of the surrounding seafloor were determined, and sediment cores were collected for studies of artificial radionuclide distribution, geotechnical properties, geochemical properties, and to identify the character of shallow acoustic reflectors. Large volume water samples for artificial radionuclide studies and suspended sediment were also collected. These samples and data will supplement earlier material to be used in the evaluation of the central North Pacific as a potential site for the ultimate disposal of high-level reactor wastes. (auth)

4604 (ORNL—5050, pp 4-19) **Waste management.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

Status of the following studies is reported: Geologic Disposal Evaluation Program; processing modifications for improved waste management; leaching of radionuclides from waste solids; methods for management of ORNL liquid wastes; and projections of radioactive wastes from the nuclear fuel cycle. (LK)

4605 (ORNL—5050, pp 96-100) **Miscellaneous programs.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

Miscellaneous programs reported included resource studies; studies involving tests of obsolete casks; disposal of ORNL radioactive waste by hydraulic fracturing; storage, purification, and distribution of ^{233}U; chemical applications of nuclear explosives; preparation of training guides for nuclear facility personnel; and environmental impact statement on the U. S. nuclear power export program. (LK)

4606 (ORNL—5060) **Models for calculating the effects of isotopic exchange, radioactive decay, and of recycle in removing iodine from gas and liquid streams.** Davis, W. Jr. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 38p. Dep. NTIS $4.00.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

4607 (BNWL-SA—5559) **System design and evaluation for nation safeguards systems.** Bennett, C.A.; Murphey, W.N.; Sherr, T.S. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. 27p. (CONF-751017—14). Dep. NTIS $5.00.

From Symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

The discussion of the societal risk approach covers: definition of risk; the safeguards problem; the safeguards system; evaluation of risk; and utilization of the societal risk model. (LK)

4608 (LA—6040-PR) **Nuclear analysis research and development. Program status report, January—April 1975.** (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1975. Contract W-7405-ENG-36. 17p. Dep. NTIS $4.00.

Progress is reported in the following areas of research: neutron interrogation (active) assay applications; passive assay applications; and, instrument development and measurement controls. The ERDA-sponsored nondestructive assay training program is discussed. (JGB)

4609 (LA—6045-SR) **Analytical methods for fissionable materials in the nuclear fuel cycle. Covering June 1974—June 1975.** Waterbury, G.R. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-Eng-36. 14p. Dep. NTIS $4.00.

Research progress is reported on method development for the dissolution of difficult-to-dissolve materials, the automated analysis of plutonium and uranium, the preparation of plutonium materials for the Safeguard Analytical Laboratory Evaluation (SALE) Program, and the analysis of HTGR fuel and SALE uranium materials. The previously developed Teflon-container, metal-shell apparatus was applied to the dissolution of various nuclear materials. Gas—solid reactions, mainly using chlorine at elevated temperatures, are promising for separating uranium from refractory compounds. An automated spectrophotometer designed for determining plutonium and uranium was tested successfully. Procedures were developed for this instrument to analyze uranium—plutonium mixtures and the effects of diverse ions upon the analysis of plutonium and uranium were further established. A versatile apparatus was assembled to develop electrotitrimetric methods that will serve as the basis for precise automated determinations of plutonium. Plutonium materials prepared for the Safeguard Analytical Laboratory Evaluation (SALE) Program were plutonium oxide, uranium—plutonium mixed oxide, and plutonium metal. Improvements were made in the methods used for determining uranium in HTGR fuel materials and SALE uranium materials. Plutonium metal samples were prepared, characterized, and distributed, and half-life measurements were in progress as part of an inter-ERDA-laboratory program to measure accurately the half-lives of long-lived plutonium isotopes. (auth)

4610 (SAND—75-5351) **Advanced physical protection systems for nuclear materials.** Jones, O.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. 21p. (CONF-751017—13). Dep. NTIS $4.50.

From Symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

Because of the increasing incidence of terrorism, there is growing concern that nuclear materials and facilities need improved physical protection against theft, diversion, or sabotage. Physical protection systems for facilities or transportation which have balanced effectiveness include information systems, access denial systems, adequate and timely response, recovery capability, and use denial methods for despoiling special nuclear materials (SNM). The role of these elements in reducing societal risk is described; however, it is noted that, similar to nuclear war, the absolute risks of nuclear theft and sabotage are basically unquantifiable. Sandia Laboratories has a major Energy Research and Development Administration (ERDA) role in developing advanced physical protection systems for improving the security of both SNM and facilities. These activities are surveyed. A computer simulation model is being developed to assess the cost-effectiveness of alternative physical protection systems under various levels of threat. Improved physical protection equipment such as perimeter and interior alarms, secure portals, and fixed and remotely-activated barriers is being developed and tested. In addition, complete prototype protection systems are being developed for representative nuclear facilities. An example is shown for a plutonium storage vault. The ERDA safe-secure transportation system for highway shipments of all significant quantities of government-owned SNM is described. Adversary simulation as a tool for testing and evaluating physical protection systems is discussed. A list of measures is given for assessing overall physical protection system performance. (auth)

ADMINISTRATIVE AND REGULATORY

4611 (UCRL—13638) **Quantitative evaluation of the RETIMAC system.** Bain, E.E.; Fisher, R.H.; Gozani, T.; Harris, L. Jr.; Kendrick, H.; Kull, L.A.; Murri, E.L.; Ollivier, R.T.; Simmons, G.L. (Science Applications, Inc., La Jolla, Calif. (USA)). 10 Jun 1975. 180p. Dep. NTIS $8.50.

For Lawrence Livermore Lab., CA.

One means of raising the degree of protection afforded strategic special nuclear materials against theft and diversion is the installation of Real Time Material Control (RETIMAC) systems. The ability of RETIMAC to detect any covert attempt to steal special nuclear materials in a time frame that is adequate to contain subcritical quantities of special nuclear material within the boundaries of the material protection system and to maintain current knowledge of the quantity and location of all strategic special nuclear material was tested. A commercial-scale mixed oxide fuel fabrication plant was chosen for the study. (LK)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

4612 (CONF-750968—1) **Preparation of targets using an isotope separator.** Tracy, J.G.; Dagenhart, W.K. (Oak Ridge National Lab., Tenn. (USA)). 1975. 14p. Dep. NTIS $4.00.

From 4. annual international conference of the Nuclear Target Development Society; Argonne, Illinois, USA (29 Sep 1975).

The 180° Oak Ridge Sector Isotope Separator (ORSIS) is used for preparing enriched isotopic ion-implanted targets. The ORSIS and receiver and their operation in target preparation are described. Assays of ORSIS targets (^{156}Dy, ^{158}Dy, ^{162}Er, ^{164}Er, ^{154}Gd) are compared with these for calutron separations. (DLC)

PHYSICAL ISOTOPE SEPARATION

4613 (UCRL-Trans—10919) **Efficiency of selective two-step laser action in an atomic beam.** Karlov, N.V.; Prokhorov, A.M. Translated from *Kvantovaya Elektron. (Moscow)*; 2: No. 5, 1071-1074(1975). 7p. Dep. NTIS $4.50.

Formulas are given which make it possible to analyze the efficiency of selective two-step laser action in an atomic (molecular) beam as a function of such parameters as the intensity of selective and nonselective radiation, lifetime of the excited state and absorption cross section, and velocity of the beam and its extent. (LK)

HEAVY WATER PRODUCTION

4614 (UCRL—52000-75-10, pp 1-10) **Heavy water production: new LLL studies.** Oct 1975.

In Lawrence Livermore Laboratory energy and technology review.

Studies of methods for producing heavy water on a large scale are described. The basic goal is a threefold reduction in U.S. production costs (currently $125 to 135/kg). The heavy water inventory in heavy water reactors now accounts for 20 to 30 percent of their total cost. The four advanced technologies being studied include: (1) isotopically selective single-step photodissociation, which capitalizes on differences in the optical absorptivity of normal and deuterated species to effect large isotopic selectivities in photochemical decomposition reactions; (2) isotopically selective two-step photolysis, which couples isotopically selective vibrational excitation of the desired species with radiative raising of the energy of the excited molecules to near their dissociation edge, from where isotopically selective chemical decomposition occurs; (3) isotopically selective photodesorption, which uses low-energy photons to induce isotopically selective desorption of molecules from transparent surfaces; and (4) metallic chromatographic separation, by which deuterium is separated from protium by displacement chromatography in a column packed with an intermetallic compound of, for example, a rare earth and a transition metal. Theoretically, each of these processes offers the potential for a considerable savings in heavy water production costs. The plan is to continue investigating each until a clear choice can be made of which process to pursue through pilot-plant construction. (TFD)

RADIATION SOURCES

4615 (BNL—20437) **Multilayer monochromators for neutron scattering.** Saxena, A.M.; Schoenbon, B.P. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 38p. (CONF-750629—5). Dep. NTIS $5.00.

From Symposium on neutron scattering for the analysis of biological structures; Upton, New York, USA (2 Jun 1975).

In an earlier paper Schoenborn, Caspar, and Kammerer (J. Appl. Cryst. 7, 508-10(1974)) reported the fabrication of thin film monochromators for neutrons. They showed that a multilayer consisting of alternating films of two materials acts as a good monochromator with large and adjustable periodicity and wide bandwidth. The diffraction properties of these multilayers have been studied with the objective of using them as monochromators, filters and polarizers for neutrons. A theoretical understanding of these multilayers has been developed by using the kinematical and dynamical approaches. In order to compare these expressions with the observed properties, the effects of beam divergence and wavelength distribution for the spectrometer have been determined. The influence of some aperiodicity on the diffraction data has also been studied within the framework of kinematical theory. (auth)

DESIGN AND FABRICATION

4616 (DP-MS—75-9) **Equipment and operations for preparing ^{252}Cf neutron sources for interstitial cancer radiotherapy research.** Walker, V.W. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Plant). 1975. Contract AT(07-2)-1. 22p. (CONF-751101—21). Dep. NTIS $4.25.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The Savannah River Laboratory (SRL) is currently producing californium-252 sources for a medical evaluation program in neutron radiotherapy. These sources provide an intense, tiny, neutron point source for cancer therapy research. Instead of using a large beam of neutrons from a reactor or accelerator for tumor treatments, the implantable ^{252}Cf neutron source delivers a highly localized radiation dose within the tumor itself. The equipment design and operations for producing the sources, the Pt-Ir clad wire containing the Pd-Cf_2O_3 cermet core, and the assembly of 3 to 12 seeds sealed within a radiation resistant 1.20 mm plastic tube are described. All operations are performed by machines specially designed for remote operation in a shielded cell. (auth)

4617 (DP-MS—75-103) **Fabrication of intense neutron sources for medical applications.** Boulogne, A.R.; Walker, V.W. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 18p. (CONF-751114—3). Dep. NTIS $4.50.

From Californium-252 utilization meeting; San Diego, California, USA (4 Nov 1975).

Simulated sources containing ^{252}Cf equivalents of 0.1 to 1.0 milligrams were prepared. Samarium was used as the simulant in a modified chemical plating technique similar to that used to prepare palladium-californium oxide cermet for industrial applications. The length of the platinum-10 percent iridium doubly encapsulated source with its protective sheath is 0.545 in. (14.1 mm). Outside dia of the source, including its sheath, is 0.109 in. (2.8 mm). Existing "Brachytrons" can accommodate this source form. This capsule system will withstand internal gas pressures from helium due to alpha decay and fission gases from a 1 mg ^{252}Cf source after ten years if the source is subjected to a maximum temperature of 800°C, the theoretical temperature of an accidental fire. Under these conditions the safety factor is 3. The capsule system is being tested with tracer amounts of ^{252}Cf to ensure that it will withstand adverse service conditions as well as tests specified for Special Form Materials. (auth)

ISOTOPIC POWER SUPPLIES

4618 (ORNL-TM—4908) **Compatibility of $^{244}Cm_2O_3$ with containment materials for electric power generator systems.** DiStefano, J.R. (Oak Ridge National Lab., Tenn. (USA)). Dec 1975. Contract W-7405-eng-26. 60p. Dep. NTIS $5.45.

Curium-244 sesquioxide has many properties that makes it attractive as a heat source in electric power generator systems. Current radioisotopic thermoelectric generator designs generally specify fuel-containing interface temperatures from 800 to 1400°C. Results of compatibility tests of $^{244}Cm_2O_3$ with a variety of materials are reported. Test conditions included 5000 h at 900 and 1400°C, 2500 h at 1100°C, and static helium and dynamic vacuum environments. Materials included graphite, ThO_2, superalloys, noble metals, and refractory metals. (auth)

4619 (SC-PR—67-837) **Space isotope power program. Quarterly report, July—December 1967.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1967. 62p. Dep. NTIS $5.50.

Declassified 3 Mar 1975.

Progress during July to October 1967 in the Space Isotope Power Program at Sandia Laboratories is reported. (LCL)

4620 (SC-PR—69-20) **Space isotope power program. Quarterly report, October—December 1968.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1969. 56p. Dep. NTIS $5.50.

Declassified 2 Nov 1971.

Progress during October through December 1968 in the Space Isotope Power Program at the Sandia Laboratories is reported. (LCL)

DESIGN AND FABRICATION

4621 (FSEC-NSG—217-75/50) **Nuclear heat sources for cryogenic refrigerator applications.** Raab, B.; Schock, A.; King, W.G.; Kline, T.; Russo, F.A. (Fairchild Space and Electronics Co., Germantown, Md. (USA)). 6 Jun 1975. Contract AT(49-15)-3063. 73p. (ERDA-SNS—3063-7). Dep. NTIS $6.75.

Spacecraft cryogenic refrigerators require thermal inputs on the order of 1000 W. First, the characteristics of solar-electric and radioisotope heat source systems for supplying this thermal input are compared. Then the design of a ^{238}Pu heat source for this application is described, and equipment for shipping and handling the heat source is discussed. (LCL)

USES

4622 (LA-UR—75-2037) **Interaction of $^{238}PuO_2$ heat sources with terrestrial and aquatic environments.** Patterson, J.H.; Nelson, G.B.; Matlack, G.M.; Waterbury, G.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 28p. (CONF-751105—8; SM—199/100). Dep. NTIS $5.00.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

Radioisotope thermoelectric generators used in space missions are designed with a great factor of safety to ensure that they will withstand reentry from orbit and impact with the earth, and safely contain the nuclear fuel until it is recovered. Existing designs, utilizing $^{238}PuO_2$ fuel, have proved more than adequately safe. More data about the interaction of this material with terrestrial and aquatic environments is continually being sought to predict the behavior of these heat sources in the extremely unlikely contact of these materials with the land or ocean. Terrestrial environments are simulated with large environmental chambers that permit control of temperature, humidity, and rainfall using different kinds of soils. Rain falling on thermally hot chunks of $^{238}PuO_2$ causes the spallation of the surface of the fuel into extremely fine particles, as small as 50 nm, that are later transported downward through the soil. Some of the plutonia particles become agglomerated with soil particles. Plutonium transport is more significant during winter than during summer because evaporation losses from the soil are less in winter. Aquatic environments are simulated with large aquaria that provide temperature and aeration control. Earlier fuel designs that employed a plutonia-molybdenum cermet showed plutonium release rates of about 10 $\mu Ci/m^2 - s$, referred to the total surface area of the cermet. Present advanced fuels, employing pure plutonium oxide, show release rates of about 20 $nCi/m^2 - s$ in seawater and about 150 $nCi/m^2 - s$ in freshwater. The temperature of these more advanced heat sources does not seem to affect the release rate in seawater. (auth)

HYDROGEN

PRODUCTION

4623 Aqueous homogeneous reactor for hydrogen production. Kerr, W.; Majumdar, D.P. (Univ. of Michigan, Ann Arbor). pp 167-181 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Hydrogen production by radiolysis of water in aqueous reactors is described. We consider three reactor designs and discuss the essential features of each. The use of thermal neutron leakage into an aqueous blanket surrounding the main power generating part of the reactor is treated. We elaborate on the potential of a low power reactor for production of hydrogen. The amount of hydrogen produced is given approximately by 40 PfG lb/day, where P is the thermal power of the reactor in megawatts, f is the fraction of thermal energy available for water decomposition and G is the total molecular yield of hydrogen per 100 eV of deposited energy. Since G does not change appreciably with temperature hydrogen production of the reactor is nearly temperature independent. The design of a system to extract the hydrogen generated by the fission fragments and other charged particles is considered. Particular attention must be given to an explosive mixture of hydrogen and other compounds produced and the possibility of loss of hydrogen by recombination. It is shown that the energy efficiency of hydrogen production by such a reactor is given approximately by 3.0 fG%. Since G is small, a reactor built entirely for hydrogen production is perhaps not economical from an energy conservation viewpoint. However, a reasonable G factor makes it financially attractive because no turbine-generator or electrolysis equipment is required. (auth)

4624 Photolysis of water as a solar energy conversion process: an assessment. Paleocrassas, S.N. (Tri-State Coll., Angola, IN). pp 243-253 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

One of the less conventional solar energy conversion methods is the photocatalytic decomposition of H_2O to generate H_2 and O_2 directly. This paper presents an assessment of photolysis of water by sunlight. Calculations are used to establish efficiency upper limits for this type of energy conversion method using three differing photocatalysts: compound slats, compound semiconductors, and photosynthetic dyes. The efficiencies were estimated to be 3%, 28%, and 7%, respectively. (auth)

4625 Hydrogen and food production from nuclear heat and municipal wastes. Antal, M.J. Jr. (Los Alamos Scientific Lab., NM). pp 331-338 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

A set of biochemical reactions are proposed to decompose water into hydrogen and oxygen using nuclear heat and a carbon cycle. These reactions have favorable equilibrium constants at temperatures below 600°C, and produce food (algae) as a valuable by-product. Municipal wastes can be used as a source of carbon for these reactions, or the algae can be recycled. (auth)

ELECTROLYSIS

4626 (BNL—20420) Hydrogen storage and production in utility systems. Fifth quarterly progress report, January 1—March 31, 1975. Salzano, F.J. (ed.). (Brookhaven National Lab., Upton, N.Y. (USA)). Apr 1975. 106p. Dep. NTIS $6.50.

Two material (FeTi) attrition test beds A-1-1 and A-1-2 containing NL-1 material were routinely cycled to 200 to 330 times respectively as part of a program of long-term testing. Work on the aluminum test bed, which will allow higher heat fluxes, is completed and work on final assembly was initiated. The safety study on FeTi by the Denver Research Institute has been completed. Work has continued on the pressure, temperature, composition characterization of commerical FeTi material. Data are reported for NL-2 and a special commercial composition. The behavior of the NL-2 material is found to approach the behavior of zone-refined FeTi. The final results of the short-term hydrogen gas screening tests of prospective container materials for FeTi have been completed by Sandia and candidate materials selected for further testing under stress in FeTi at BNL. Work on the test fixtures and test vessel are progressing. Work was completed on the design of a small 4-in.-diam. transparent two-cell bipolar water electrolysis unit for separator materials testing. Additional data on the behavior of the dynamic hydrogen reference electrode are reported. Data are reported on the electrocatalytic behavior of nickel-based alloys using a new dynamic method of obtaining Tafel slopes. A comparison is made between the results using the steady state and dynamic methods. New data are presented on the temperature dependence of the hydrogen and oxygen evolution reactions at nickel electrodes in alkaline solution. (LK)

4627 Sea thermal power as a hydrogen and methanol generator. Anderson, J.H. (Sea Solar Power, Inc., York, PA). pp 197-207 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Power is the major ingredient for making hydrogen and/or methanol, fresh water, and valuable minerals. The most abundant inexhaustible and least expensive source of power is from the thermal temperature differences in the ocean. The sun maintains the temperature differences in the ocean which is the largest natural collector and reservoir and solar energy. The cost of power to synthesize other fuels will be lower with sea solar power plants than by fossil, nuclear, or any other proposed method. (auth)

4628 Ocean based solar-to-hydrogen energy conversion macro system. Escher, W.J.D. (Escher Technology Associates, St. Johns, MI); Hanson, J.A. pp 209-229 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

An initial conceptualization of an ocean based solar-to-hydrogen energy conversion facility is presented. It is proposed to use hydrogen as an energy carrier to be delivered to the spectrum of energy-using sectors, instead of electricity, because of hydrogen's advantages of transportability and storability. These make hydrogen and solar energy natural adjuncts. It is further proposed that the solar-to-hydrogen conversion process be conducted on the open ocean, and not in the traditional desert location. The advantages, we suggest, far outweigh the drawbacks. In addition to well-established marine engineering know-how, we foresee the need for a new class of large ocean stable platforms upon which to base the industrial complex. It is not yet apparent to us what specific solar energy conversion mode, or combination of modes, should be selected among the several direct and indirect techniques available. Economics and available technology will control this choice as illuminated by further study. In addition to the exportation of hydrogen-energy, in the form of cryogenic liquid hydrogen and oxygen transported in tankers, it is highly likely that a number of coproducts can also be profitably supplied by the ocean complex were it appropriately outfitted. Among the possibilities are: seafoods via open ocean mariculture, minerals and chemicals such as salt and fertilizers, and certain finished materials (especially those which are energy-intensive) such as magnesium and aluminum. (auth)

4629 Analysis of hydrogen production via closed-cycle schemes. Chao, R.E. (Univ. of Puerto Rico, Mayaguez); Cox, K.E. pp 317-330 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

A thermodynamic analysis and state-of-the-art review of three basic schemes for production of hydrogen from water: electrolysis, thermal water-splitting, and multi-step thermochemical closed cycles is presented. Criteria for work-saving thermochemical closed-cycle processes are established and several schemes are reviewed in light of such criteria. An economic analysis is also presented in the context of energy costs. (auth)

4630 Methods for the large-scale production of hydrogen from water. Bockris, J.O. (Flinders Univ., Adelaide). pp 371-403 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Off-peak power would give sufficiently cheap hydrogen with classical electrolyzers. Emerging technology could produce it at between \$0.85 and \$2.90 $(10^6\ \text{Btu})^{-1}$ for electricity costs (bulk purchase) between 2 and 7 mils. High temperature electrolyzers are less advantageous than thermal assisted electrolysis of cuprous chloride (\$2.08). Photoelectrochemical methods project costs at less than \$0.70; photosynthetic at \$0.40. Research stress should be on: use of off-peak power, cuprous chloride electrolysis, photo-oriented methods. The latter could offer hydrogen cheaper than from present natural gas. (auth)

4631 Electrolytic hydrogen generators. Laskin, J.B. (Teledyne Isotopes, Timonium, MD). pp 405-415 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

The energy crisis and associated fuel shortages have propagated many proposals to attain energy independence and develop new sources of energy. The approach of a "Hydrogen Economy" is one of these proposals. The present-day use of hydrogen in the pollution control, metals processing, electric utilities and other industries has resulted in the creation of a series of commercial electrolytic generators for on-site generation of hydrogen. Three types of generators (small, intermediate and large size) presently used to generate hydrogen as a commodity are avaliable for the "Hydrogen Economy" concept to be used in the generation of hydrogen as an energy distribution media or as a storage intermediary. (auth)

4632 Electrolysis of sea water. Williams, L.O. (Martin Marietta Aerospace, Denver). pp 417-424 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

In implementation of the hydrogen economy, the electrolysis of seawater as the source of hydrogen has been discussed. Two options exist for performance of this electrolysis. The first option is to subject the water to total desalinization to remove all impurities and produce essentially distilled water. This distilled water can then be subjected to electrolysis in conventional, alkaline electrolyte, electrolysis cells. The disadvantages of this approach are the capital costs of the water purification equipment and the environmental problem arising from the need to dispose of the residual salts removed during desalinization. The advantages are the ability to use developed technology. The second option is to design electrolyzer systems capable of utilizing natural seawater to perform the electrolysis. It is probable that these systems would operate at a low power density and electrolyze only a small portion of the water in contact with electrodes. The disadvantages are new technology must be developed to solve the probable corrosion and contamination problems and undesirable electrochemical products such as chlorine. The advantages are possible lower capital costs and natural elimination of the waste brine which is only slightly enriched with salts. It may also be possible to recover economically significant quantities of the metals present in seawater that are less active electrochemically than hydrogen: silver, gold, mercury, and copper. Preliminary data indicate that low current densities are insufficient to prevent deposits and chlorine formation and that while hydrogen can be produced at reasonable efficiency (89%), the overall process may not be environmentally acceptable for very large-scale applications. (auth)

4633 Hydrogen generation through static feed water electrolysis. Jensen, F.C.; Schubert, F.H. (Life Systems, Inc., Cleveland). pp 425-439 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Life Systems' Static Feed Water Electrolysis System (SFWES) concept, developed under NASA sponsorship, is presented for potential applicability to terrestrial hydrogen production. The SFWES concept uses (1) an alkaline electrolyte to minimize power requirements and materials compatibility problems, (2) a method where the electrolyte is retained in a thin porous matrix eliminating bulk electrolyte, and (3) a static water feed mechanism to prevent electrode and electrolyte contamination and to promote system simplicity. (auth)

4634 Hydrogen generation by solid polymer electrolyte water electrolysis. Nuttall, L.J.; Fickett, A.P.; Titterington, W.A. (General Electric Co., Lynn, MA). pp 441-455 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

The General Electric Company water electrolysis technology, which is based on a solid polymer electrolyte (SPE) concept, is presented for applicability to large-scale hydrogen production in a future energy system. High cell current density operation is selected for the application, and supporting cell test performance data are presented. The inherent system advantages of the acid SPE electrolysis technology are explained. System performance predictions are made through the year 2000, along with plant capital and operating cost projections. (auth)

4635 Hydrogen production by water electrolysis: methods for approaching ideal efficiencies. Kissel, G.; Lu, P.W.T.; Miles, M.H.; Srinivasan, S. (Brookhaven National Lab., Upton, NY). pp 1194-1198 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

For hydrogen production by water electrolysis to be competitive with the conventional methods, it is necessary to operate the electrolysis cells at high current densities (approximately equal to 1 amp cm^{-2}) and at high voltage efficiencies (close to 100 percent based on the higher heating value). Activation overpotential and ohmic overpotential contribute to the efficiency losses in water electrolysis cells. The methods of improving the efficiencies of water electrolysis cells are (i) maximization of real to apparent surface area of electrodes to reduce activation overpotential, (ii) increase of operating temperature to reduce activation and ohmic overpotential losses, and (iii) reduce the thickness between electrodes to decrease the ohmic drop in the cell. The present studies show that (i) in the General Electric Solid Polymer electrolyte cell, with high surface area electodes, efficiencies close to 100 percent can be achieved at 80°C; (ii) in the KOH electrolyte cell (e.g., Teledyne) using nickel electrodes, activation overpotentials at the hydrogen and oxygen electrodes are the main causes of efficiency losses; (iii) an alkaline cell can operate at close to 100 percent efficiency with nickel electrodes at 150°C; (iv) to operate at 150°C, it is necessary to replace asbestos, the currently used separator material. Potassium titanate appears promising; and (v) elimination of the barrier (used to keep hydrogen and oxygen separated) can reduce cell resistance. (auth)

THERMOCHEMICAL PROCESSES

4636 Nuclear water splitting and high temperature reactors. Barnert, H.; Schulten, R. (Nuclear Research Center, Juelich, Ger.). pp 115-128 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

The energy market in Germany and Europe is compared with that in the U.S.A. with the conclusion that nuclear energy is a very promising primary energy source for Germany and that the Nuclear Water Splitting seems to be the best method to make nuclear energy applicable. The motivations for research and development of the Nuclear Water Splitting are given. It is reported about activities in the Nuclear Research Center Juelich, especially on experiments for thermochemical cycles. First results for a Nuclear Hydrogen Plant in a Hydrogen Economy are given. (auth)

4637 High-temperature nuclear reactors as an energy source for hydrogen production. Balcomb, J.D.; Booth, L.A. (Los Alamos Scientific Lab., NM). pp 129-136 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Application of current high-temperature reactor technology to hydrogen production is reviewed. The requirements and problems of matching a thermochemical hydrogen production cycle to a nuclear heat source are discussed. Possibilities for extending the temperature of reactors upward are outlined. The major engineering problem is identified as the development of a high-temperature process heat exchanger separating the nuclear heat source from the chemical process. (auth)

4638 Hydogen production with a high-temperature gas-cooled reactor (HTGR). Quade, R.N.; McMain, A.T. (General Atomic Co., San Diego, CA). pp 137-154 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Use of the HTGR as a major supplier of electric energy has been established. However, the total market for energy forms other than electricity is large and represents a new potential use for nuclear reactors. Of the many ways an HTGR can be applied to a chemical process to produce hydrogen, two are discussed in detail. One is for steam hydrocarbon reforming, which might be considered a thermochemical open cycle process; and the other is water-splitting - a thermochemical closed cycle process. (auth)

4639 Hydrogen production from decomposition of water by means of nuclear reactor heat. Dorner, S. (Inst. fuer Neutronphysik und Reaktortechnik, Postfach, Ger.); Keller, C. pp 155-166 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

A closed cycle process is described for the production of hydrogen from water by means of nuclear heat. The following steps are needed: dissolution of a metal, preferable Ag, in hydrohalogenic acids; transformation of the silver halide into silver and oxygen by means of alkaline hydroxides; splitting the alkaline halide into the basic and acid components by a chemical reaction or by electrolysis. A critical discussion, however, shows that at present the question can't be answered whether this process can be realized in practice. (auth)

4640 Thermochemical water cracking using solar heat. Swet, C.J. (Johns Hopkins Univ., Silver Spring, MD). pp 231-242 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Direct solar radiation is shown to be a potentially superior source of energy for the thermochemical production of hydrogen from water, especially in a regionally self-sufficient hydrogen economy. Its impact on chemical cycle selection, conversion efficiency, operating mode, plant siting, plant capacity, and product cost is compared with that of a nuclear heat source. Conceptual designs and development goals are suggested. (auth)

4641 Economic criteria of selection for closed cycle thermochemical water splitting processes. Joly, F. (Pechiney Ugine Kuhlmann, Paris). pp 279-289 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

By elementary economic considerations, it is possible to predict in which range of costs future thermochemical water splitting plants must fall and/to quantify the importance of the heat efficiency factor. It is shown that material balance is likely to be a dominant factor and that the yield of recovery of products should be given prime consideration in research on thermochemical water splitting cycles. (auth)

4642 Evaluation of multi-step thermochemical processes for the production of hydrogen from water. Funk, J.E.; Conger, W.L.; Carty, R.H. (Univ. of Kentucky, Lexington). pp 457-469 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

An evaluation procedure for multi-step thermochemical water decomposition processes is described. It provides for the determination of changes in thermodynamic properties inside the process and can be used to study the effect of operating temperatures, approach to equilibrium in the chemical reactions, and thermal regeneration on the process thermal efficiency. Work of separation and recycle requirements are obtained in the course of the analysis. The procedure is demonstrated by application to a number of processes. (auth)

4643 Considerations on iron—chloride—oxygen reactions in relation to thermochemical water-splitting. DeBeni, G. (EURATOM, Ispra, Italy). pp 471-482 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

The properties of iron oxides and chlorides allow the construction of many thermochemical cycles for water-splitting. There are three fundamental steps in every cycle. Evaluations of these steps for different paths are given. The state of the knowledge of the chemical reactions is examined and the critical items that need further development are indicated. (auth)

4644 Thermochemical hydrogen production research at Lawrence Livermore Laboratory. Hickman, R.G.; Krikorian, O.H.; Ramsey, W.J. (Univ. of California, Livermore). pp 483-498 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Three novel closed-cycle processes for the thermochemical production of hydrogen from water are under study at the Lawrence Livermore Laboratory. The first cycle is based upon selenium and its compounds, the second on mercury, and the third on methane and methanol. None of these cycles involves halogens, and reaction temperatures are limited to 700°C. Although still in the conceptual stages, some preliminary experiments have been conducted on the first two processes, with the main effort on the first process. (auth)

4645 Analysis of thermochemical water-splitting cycles. Pangborn, J.B.; Sharer, J.C. (Inst. of Gas Tech., Chicago). pp 499-515 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

The Institute of Gas Technology (IGT), under the sponsorship of the American Gas Association, is conducting a research program, now in its third year, to derive, evaluate, and experimentally test closed-cycle chemical reaction sequences for splitting water into hydrogen and oxygen. A brief description of the IGT program and an analysis technique for evaluating water-splitting cycles when heat is the primary energy source are presented. The treatment is applied to four cycles, and efficiency comparisons with electrolysis are made. (auth)

4646 Search for thermochemical water-splitting cycles. Russell, J.L. Jr.; Porter, J.T. (General Atomic Co., San Diego, CA). pp 517-529 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

A computer-aided search is in progress at General Atomic Company for thermochemical processes for decomposing water. The computer program is described, the thermodynamic assumptions are presented, and some representative results are discussed. (auth)

STEAM REFORMER PROCESSES

4647 Hydrogen opportunities in Saudi Arabia. Adbel-Aal, H.K.; Peattie, E.C. (Coll. of Petroleum and Minerals, Dhahran, Saudi Arabia). pp 345-369 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

A source of hydrogen is the methane in the well-head gas from the oil fields of Saudi Arabia. 2.5 billion cubic feet per day are available and it is possible to design a plant using one billion cubic feet per day with a production of 8700 tons of liquified hydrogen. Three alternative methods are examined: the LNG route, the methanol route and the direct manufacturer and liquefication in Saudi Arabia. These methods are described in detail, costs are developed and the processes are evaluated by economic indicators for profitability. While both methanol and direct liquefication are of about equal economic attractiveness, the latter is recommended for Saudi Arabia. (auth)

BIOSYNTHESIS

4648 Utilization of solar energy for hydrogen production by cell free system of photosynthetic organisms. Mitsui, A. (Univ. of Miami, FL). pp 309-316 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

The production of hydrogen by a cell free system of photosynthetic organisms is discussed. This represents a potential source of energy that does not exploit traditional energy resources but utilizes available solar radiation. Screening of tropical and subtropical marine photosynthetic bacteria and algae which exhibit a high activity for the photoproduction of hydrogen is also proposed. (auth)

STORAGE

CHEMISORPTION

4649 Activation of a lanthanum—nickel-five hydrogen absorbent (research film). van Mal, H.H. (Philips Research Labs., Eindhoven, Netherlands). pp 605-610 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

The intermetallic compound $LaNi_5$ forms the hydride $LaNi_5H_6$ under 1.5 atm of hydrogen pressure at room temperature and has a high rate of sorption. $LaNi_5$-hydride has several attractive properties, making it suitable for various applications. It is also relatively easy to make the $LaNi_5$ absorb hydrogen for the first time; there is no necessity to granulate the material. The activation process has been filmed and will be demonstrated in a movie. (auth)

4650 Engineering-scale energy storage reservoir of iron titanium hydride. Strickland, G.; Reilly, J.J.; Wiswall, R.H. Jr. (Brookhaven National Lab., Upton, NY). pp 611-620 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

A hydrogen reservoir containing 14 lb of H_2 in the form of 893 lb of granular iron titanium hydride was constructed and tested. The reservoir will be used by Public Service Electric and Gas Company of New Jersey to study the feasibility of storing off-peak electrical energy through the use of a water electrolyzer, a hydride reservoir and a fuel cell stack. The internal functional components of the stainless steel vessel consist of a barrier in the form of porous metal tubes, and heat exchanger tubes. Details of construction, preparation of the hydride, and performance tests made at BNL are described. (auth)

4651 Modeling studies of fixed-bed metal-hydride storage systems. Yu, W.S.; Suuberg, E.; Waide, C. (Brookhaven National Lab., Upton, NY). pp 621-643 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Modeling studies are of a practical importance in understanding and characterizing the behavior of hydride beds now being developed for storing and supplying hydrogen fuel in power plant and automotive applications. A convective bed model, in which heat is transferred to or from the bed by a flowing stream of hydrogen in direct contact with the particles, and a conduction model in which heat is transferred through a containment wall, were developed. $FeTiH_2$ and catalyzed MgH_2 were evaluated using the model. (auth)

4652 Formation and properties of rare-earth and transition metal hydrides. Beavis, L.C.; Blewer, R.S.; Guthrie, J.W.; Nowak, E.J.; Perkins, W.G. (Sandia Labs., Albuquerque, NM). pp 659-674 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Research on metal hydrides indicates that surface chemical effects and dynamic thermal properties will play major roles in the use of these materials as hydrogen fuel storage media. Various techniques have been developed to optimize the formation of metal hydride films, and near-surface analytical techniques including ion microprobe mass analysis, Auger electron spectroscopy, and proton backscattering have been used to elucidate the surface chemistry of these materials. Thermal diffusivities have been measured for hydrides of Sc, Y, Zr, and Er. (auth)

UNDERGROUND

4653 (GA-A—13651) Engineering design of a thermochemical water-splitting cycle. DeGraaf, J.; Porter, J.; Russell, J. (General Atomic Co., San Diego, Calif. (USA)). 30 Sep 1975. Contract E(04-3)-167. 17p. Dep. NTIS $4.50.

In collaboration with Los Alamos Scientific Laboratory, the LASL baseline sulfuric acid-sulfur-oxide-sulfide cycle to thermochemically split water has been selected for engineering design. A block diagram defining the functional requirements of the subsystems has been developed and the thermochemical and general chemical characteristics of the processes reviewed. Heat and mass balance calculations have been completed in the first iteration for one of the subsystems. Experimental difficulties reported by LASL could make it impossible to properly fix some reaction conditions and stream compositions on a timely basis. In this event, some arbitrary assumptions must be applied to the cycle before it can be closed. (auth)

CRYOGENIC

4654 Low thermal flux glass-fiber/metal vessels for LH_2 storage systems. Hall, C.A.; Spond, D.E. (Martin Marietta Corp., Denver). pp 561-574 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Composite tanks and tubes have been developed that consist of thin metal liners overwrapped with glass-fibers. Because the glass-fiber is a very good thermal insulator and the thin metal liner has a small cross-sectional area, the longitudinal heat conductivity is considerably reduced when compared to an all-metal design. The composite overwrapped tanks and tubes are also damage resistant and lightweight. Fabrication techniques and the use of composites to help solve the problems associated with the development of LH_2 power transportation vehicles are discussed. (auth)

TRANSPORT

4655 Pipeline transportation of hydrogen. Reynolds, R.A.; Slager, W.L. (General Electric Co., Santa Barbara, CA). pp 533-543 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

An analytic model encompassing characteristics and costs of high pressure pipeline transport of gaseous and liquid fuels has been developed. The model, which minimizes capital investment costs for a specified energy flow rate, was used to compare the transport costs of hydrogen, ammonia, oxygen, and natural gas. It is found that pipeline transmission of a given amount of energy as hydrogen costs 30-50 percent more than for natural gas. Other siting and design factors, however, suggest that total transport costs for the two fuels may be more nearly equal. The cost of cooling hydrogen for transport is greater than the saving in pipeline costs. (auth)

4656 Economics of pipeline transport for hydrogen and oxygen. Beghi, G. (EURATOM, Ispra, Italy); Dejace, J.; Massaro, C.; Milanese, S.D.; Ciborra, B. pp 545-560 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

In a Hydrogen System nuclear, power stations for water-splitting will produce large quantities of hydrogen and oxygen. Economic aspects of transmission by pipeline of these two gases is evaluated, taking methane transportation as a comparison. With a maximum transport pressure of 65 kg/cm², gas flow was considered in the range of 0.5 - 4 Gcal/sec for hydrogen and 100 - 800 Nm³/sec for oxygen; length of pipeline varies from 500 to 2000 km. Details are given on the optimized costs. (auth)

4657 Electric power and fuel transmission by liquid hydrogen superconductive pipeline. Whitelaw, R.L. (Virginia Polytechnic Inst. and State Univ., Blacksburg). pp 575-587 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

In the ultimate hydrogen economy, the twin premises are that hydrogen will be derived from solar- or nuclear-generated electric power and that most road vehicles will be fueled by liquid hydrogen at about -420°F. Thanks to four new technologies recently come to fruition, the above objective can be attained by transmitting high voltage D.C. power in a superconductive liquid hydrogen underground pipeline. (auth)

4658 Optimal location of hydrogen supply centers to minimize distribution costs. Avriel, M.; Gurovich, V. (Israel Inst. of Tech., Haifa). pp 589-604 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

The problem of where to locate in an optimal way supply centers for distributing hydrogen to given destinations is considered. A numerical method is derived based on geometric programming. This method enables efficient solution of geographically, environmentally or economically constrained problems which cannot be handled by other existing methods. (auth)

MARKETING AND ECONOMICS

4659 Comparative study of hybrid energy systems of hydrogen and electric power. Ihara, S.; Wakamatsu, S. (Electrotechnical Lab., Tokyo). pp 291-298 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

A parametric study of energy costs, which is based on the present state of energy technologies, favors electric power transmission even in the age of hydrogen economy. Present inefficiencies in hydrogen production and in the conversion of hydrogen energy into electricity must be overcome, and the coordination between electric power transmission and hydrogen transmission must be made before the establishment of hydrogen economy. (auth)

4660 Economic perspective on hydrogen fuel. Johnson, J.E. (Hydrogen Union Carbide Corp., New York). pp 299-308 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

The economics for producing various transportable energy forms from domestic resources are reviewed and compared in order to place the prospects for hydrogen fuel in better perspective. From the published data available, it would appear that liquid methane could be a more serious economic competitor to adoption of hydrogen as an aviation fuel than is synthetic kerosene. Mission energy savings in the order of 30% are required to establish clear superiority for hydrogen fuel over kerosene when the criteria for selection is fuel economics alone. Methanol is an economically preferable choice to liquid hydrogen for ground transportation systems. Clearly, the concept of hydrogen fuel for ground transportation is contingent on the success of the proposed "hydride" technology which avoids expensive liquefaction processes. To clarify economic issues regarding hydrogen fuel, much more attention to, and reporting of, energy conservation features of hydrogen fueled "engines" is required in order to obtain the favorable economic verdict to proceed on development. (auth)

SAFETY

4661 Cryogenics safety in a hydrogen fuel society. Reider, R.; Edeskuty, F.J.; Williamson, K.D. Jr. (Los Alamos Scientific Lab., NM). pp 562-565 of In Proceedings of the fifth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1974).

From 5. international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

See CONF-740509—.

Hydrogen has great potential as the "fuel of the future", to take the place of dwindling fluid fossil fuel resources. But hydrogen is, potentially, a dangerous material. This paper surveys the properties of materials, the properties of H_2, and their related hazards, the risks of transportation fuel fires, and standards, regulations and procedures. (auth)

4662 Safety characteristics of $NaNi_5$ hydrides. Lundin, C.E.; Sullivan, R.W. (Univ. of Denver). pp 645-658 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Experimental studies have been conducted to determine the limits of safety in handling, shipping, and usage of LaNi hydride. Emphasis has been given to the accident-oriented safety problems such as punctured containers, impact, explosion, shock, and external fire. Various aspects of hazards have been evaluated for bulk powders; the ignition temperature, the relative combustibility, flammability, shock sensitivity, impact sensitivity, electrostatic spark sensitivity and potential explosibility. Since the $LaNi_5$ hydrides break down to powders after repeated absorption and desorption of hydrogen, the ultimate interest in the safety considerations is with fine powders. A characterization study of the particles and particle size was included as part of the study. Another independent study was also made of the safety of dust clouds of $LaNi_5$ hydrides. The ignition sensitivity and explosion severity were determined, and an index of explosibility of dust clouds was established. (auth)

INDUSTRIAL AND COMMERCIAL USE

4663 Survey and assessment of contemporary US hydrogen-fueled internal combustion engine projects. Escher, W.J.D. (Escher Tech. Associates, St. Johns, MI). pp 1143-1155 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

By way of documenting a technical information baseline on the state of development of hydrogen-fueled internal combustion engines a survey of contemporary hydrogen engine projects in the U.S. has been carried out. The results are being documented for the Energy Research and Development Administration and will appear in report form. An overview of selected findings is presented. (auth)

OTHER SYNTHETIC AND NATURAL FUELS

4664 RESOURCE RECOVERY THRU INCINERATION. 1974 NATIONAL INCINERATOR CONFERENCE, MIAMI, FLORIDA, MAY 12—15, 1974. New York; United States of America (USA); American Society of Mechanical Engineers (1974). 378p. (CONF-7405105—).

From National incinerator conference; Miami Beach, Florida, USA (12 May 1974).

Many aspects of resource recovery from municipal and industrial wastes are considered in the 33 papers presented at the conference. These include the economics of resource or energy recovery, design and operation of specific installations, environmental aspects, safety, and the design of incinerators and incinerator systems. A companion volume contains discussion and replies for some of the papers. (JSR)

HYDROCARBON FUELS

4665 (NSF/RA/N—74-112) **Fuel gas production from solid waste. Supplemental report, subcontract programs covering the period July 1, 1973—June 30, 1974.** Cooney, C.L.; Lindsey, E.E.; Kirk, R.S.; Oyewole, S. (Dynatech R/D Co., Cambridge, Mass. (USA); Massachusetts Inst. of Tech., Cambridge (USA); Massachusetts Univ., Amherst (USA)). 31 Jul 1974. 73p. NTIS.

This report contains two final reports from Dynatech subcontractors. Part I consists of the report of the MIT program, Fuel Gas Production from Solid Waste by Thermophilic Anaerobic Digestion. The advantages of thermophilic digestion over the traditional mesophilic digestion are discussed. The primary drawback to thermophilic digestion is the need to supply heat to maintain the temperature above 50°C. It is concluded that anaerobic thermophilic digestion of cellulosic waste is a feasible operation for the production of fuel gas. The effects of residence time, recycle, and temperature on the extent of solid waste degradation, biological mass formed, and quantity and quality of gas produced are discussed. Recommendations for future research are presented. Part II is entitled Fuel Gas from Solid Waste and is the final report from the University of Massachusetts. It contains three sections: Kinetic Studies on Anaerobic Digestion of Solid Waste; Feasibility of an On-Line Instrument for Measuring Anaerobic Digestion Microbial Activity; and Development of Process Techniques for Microorganisms Separation. Details of digester operation are included in an appendix. (MPG)

SOLAR ENERGY

4666 (APL/JHU-SR—75-2, pp 174-175) **OTEC plan for resource and environmental studies.** Wolff, P.M. (Ocean Data Systems, Inc., Monterey, CA). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

This project will provide resource and environmental data related to potential Ocean Thermal Energy Conversion (OTEC) plant sites and an evaluation of environmental risks. The planned work involves six tasks: thermal structure mapping, current structure mapping, thermal profile envelopes, cross-sectional analyses, other environmental factors, and trade-off analyses and recommendations. Examples of mapping and data-presentation formats and preliminary ideas on the environmental risk studies are presented. (auth)

4667 (PB—238161) **Solar energy research information meeting of NSF-RANN grantees held at National Center for Energy Management and Power, Philadelphia, PA on 15—16 March 1973.** (National Center for Energy Management and Power, Philadelphia, Pa. (USA)). 1973. 194p. NTIS $7.00.

Contents: Solar-to-thermal energy conversion application to large central power plants; Photothermal conversion of solar energy for large-scale electrical power production; The Minnesota/Honeywell solar power concept; Solar energy thermal converters fabricated by chemical vapor deposition; Low-cost silicon solar cell for large electrical power system-growth of silicon layer on steel substrate; An improved Schottky barrier photovoltaic diode for solar energy conversion; Direct solar energy conversion for large scale terrestrial use; Modeling of solar heating and air conditioning; Conservation and better utilization of electric power by means of thermal energy storage and solar heating; Solar energy residential system modeling; Ocean sited power plants; An inquiry into biological energy conversion; Biophotolysis of water; Technology for the conversion of solar energy to fuel gas; Technology for the conversion of solar energy to fuel gas; Solar energy panel report. (GRA)

4668 **ERDA solar energy program.** Herwig, L.O. (Energy Research and Development Administration, Washington, DC). pp 2-3 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4669 **Solar energy and the law.** Thomas, W.A. (American Bar Foundation, Chicago); Robbins, R.L. pp 25-26 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

RESOURCES AND AVAILABILITY

4670 (AD/A—003932) **Summer global radiation and albedo: data for three stations in the Arctic basin, Ice Island T-3, Barrow, Prudhoe Bay, 1971—1973.** Weller, G.; Holmgren, B. (Alaska Univ., College (USA). Geophysical Inst.). Dec 1974. 40p. NTIS $3.75.

Daily means of the solar global radiation and the albedo are listed for the months of May to October for three stations in the Arctic basin, namely Ice Island T-3, Barrow and Prudhoe Bay. The data are for the years 1971 to 1973. (NTIS)

4671 (N—75-16080) **Operational performance of a low cost, air mass 2 solar simulator.** Yass, K.; Curtis, H.B. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1975. 10p. (NASA-TM-X—71662; E—8247). NTIS $3.25.

From Institute of Environmental Science conference; Los Angeles, California, USA (13 Apr 1975).

Modifications and improvements on a low cost air mass 2 solar simulator are discussed. The performance characteristics of total irradiance, uniformity of irradiance, spectral distribution, and beam subtense angle are presented. The simulator consists of an array of tungsten halogen lamps hexagonally spaced in a plane. A corresponding array of plastic Fresnel lenses shapes the output beam such that the simulator irradiates a 1.2 m by 1.2 m area with uniform collimated irradiance. Details are given concerning individual lamp output measurements and placement of the lamps. Originally, only the direct component of solar irradiance was simulated. Since the diffuse component may affect the performance of some collectors, the capability to simulate it is being added. An approach to this diffuse addition is discussed. (auth)

4672 (PB—241514) **Water Resource Observatory wind and solar radiation data: water, years 1973 and 1974.** Smith, V.E. (Wyoming Univ., Laramie (USA)). Nov 1974. 88p. (OWRT-A—015-WYO(1)). NTIS $4.75.

Wind data reduced from recording anemometer charts and from readings of totalizing anemometers plus incident solar radiation data from various stations operated by the University of Wyoming in and adjacent to Laramie, Wyoming are presented in tabular form. The period covered is from October 1972 through September 1974. (auth)

4673 (PB—242899) **Solar thermal conversion mission analysis. Volume II. Southwestern United States. Demand analysis.** (Aerospace Corp., El Segundo, Calif. (USA)). 15 Nov 1974. Contract NSF-C797. 178p. (ATR—74(7417-16)-2-VOL-2; NSF/RA/N—74-205B). NTIS $7.00.

Computer programs, data bases, and forecast methodology capable of characterizing the hourly electric power demand for selected southwestern United States load centers from 1980 to 2000 are presented and discussed. (NTIS)

4674 (PB—242900) **Solar thermal conversion mission analysis. Volume III. Southwestern United States insolation climatology.** (Aerospace Corp., El Segundo, Calif. (USA)). 15 Nov 1974. Contract NSF-C797. 220p. (ATR—74(7417-16)-2-VOL-3; NSF/RA/N—74-205C). NTIS $7.25.

An insolation data base consisting of hourly values of normal incidence or direct insolation and total insolation for a two-year period has been prepared in computer-compatible format for 20 stations characterizing the climatology of the southwestern United States. The data base includes, in addition to the insolation data, solar position and weather information. When measured insolation values were unavailable, estimated values obtained by statistical procedures discussed in this report were developed in order to complete the insolation data base. In addition, a worst-case data base has been prepared for two locations: Albuquerque, New Mexico, and Inyokern, California. These data were also used in several statistical studies to include a comparison of insolation values at various stations, a percentile frequency analysis of insolation data, a temperature-insolation correlation, and a wind insolation frequency analysis. The procedures used in these various studies and the results obtained are discussed in detail. (NTIS)

4675 (PB—243635) **Effects of atmospheric aerosols in infrared irradiance at the Earth's surface in a nonurban environment.** Riches, M.R.; Peterson, J.T.; Flowers, E.C. (North Carolina State Univ., Raleigh (USA)). May 1975. 44p. (EPA—650/4-75/017). NTIS $3.75.

This report describes a study designed to measure hemispheric infrared downward-directed irradiance at the Earth's sur-

face and ambient aerosol concentrations at research Triangle Park, North Carolina. A Funk-type net radiometer (with a blackened cavity on the underside) was used to measure the incident all-wave energy. From the value obtained, the observed solar radiation was subtracted to determine the infrared component. The expected incident infrared irradiance was calculated from prevailing atmospheric conditions. Six methods were used for these calculations. (GRA)

4676 **Measurement of circumsolar radiation.** Grether, D.; Nelson, J.; Wahlig, M. (Univ. of California, Berkeley). pp 101-102 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4677 **Estimating the direct component of solar radiation.** Boes, E.C. (Sandia Labs., Albuquerque, NM). pp 107-108 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

HEAT STORAGE AND REJECTION

4678 (TID—26907) **Solar energy subsystems employing isothermal hear sink materials. Semi-annual progress report, Sepember 18, 1974—June 31, 1975.** Lane, G.A.; Best, J.S.; Clarke, E.C.; Drake, S.S.; Glew, D.N.; Quigley, S.W.; Rossow, H.E. (Dow Chemical Co., Midland, Mich. (USA)). Jul 1975. 25p. Dep. NTIS $4.50.

A group of over 200 potential phase change heat storage materials, melting from 10 to 90°C was identified. Laboratory tests narrowed these to materials recommended for hot faucet water, hydronic heating, forced air heating, heat pump application, radiant wall panels, and stored cold systems. Several encapsulation methods were studied: micro-encapsulation, encapsulation of powders and granules, and macro-encapsulation. Micro-encapsulation of $CaCl_2 \cdot 6H_2O$ in polyester resin has been successful, and development of wall, floor, and ceiling panels is under way. Macro-encapsulation in plastic film containers appears promising for hot air systems. (auth)

4679 **Solar heat storage based on inorganic chemical reactions.** Ervin, G. (Atomics International Div., Canoga Park, CA). pp 199-200 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

SITE GEOLOGY AND METEOROLOGY

4680 (AD/A—008576) **Maritime microclimatology: the radiation balance of east-facing slopes in Barbados. Final report.** Garnier, B.J. (McGill Univ., Montreal, Quebec (Canada)). Mar 1975. Contract N00014-73-C-0194. 68p. NTIS $4.25.

A field program of ground observations and remote sensing was undertaken in Barbados during July, 1973. The program concentrated on observations of elements of the radiation balance of east-facing slopes. The data obtained showed that the surface temperatures of east-facing slopes in Barbados are higher than elsewhere in the morning and as high as elsewhere during the rest of the day. This feature appears to be related to the absorbed global radiation on east-facing slopes which is higher than elsewhere at all times owing to the relatively low albedo (0.13) here as compared with the rest of the island (0.17). Surface geometry also helps to break up early morning cloud on the east to facilitate surface heating from the morning sun. (auth)

4681 (COM—75-10983) **Weather and corn yield study for Tippecanoe County, Indiana. Final report.** Dale, R.F.; Hodges, H.F. (Purdue Univ., Lafayette, Ind. (USA)). 31 May 1975. 102p. (NOAA—75062602). NTIS $5.25.

The results of studies relating weather factors to corn yield in Tippecanoe, Indiana are presented. Technological and environmental variables are investigated in order to develop a reliable prediction model. Data for fertilization, corn population, precipitation, temperature, solar radiation, evaporation, and soil moisture are presented, and the development of models is outlined. A workable environmental variable is determined for effective estimations of corn yields. (auth)

4682 (PB—242902) **Solar thermal conversion mission analysis. Volume V. Southwestern United States. Area definition and siting analysis, southwestern United States.** (Aerospace Corp., El Segundo, Calif. (USA)). 15 Nov 1974. Contract NSF-C797. 126p. (ATR—74(7417-16)-2-VOL-5; NSF/RA/N—74-205E). NTIS $5.75.

Results of an area definition and siting analysis in support of the solar thermal conversion mission analysis study are presented. The objectives were to define and characterize the southwestern United States study region and to identify those areas within this region judged to be potentially suitable for siting large solar power plants. (NTIS)

ECONOMICS

4683 (AD/A—012416) **Thermoeconomic analysis of environmental vapor power systems.** Sheppard, F.L. Jr. (Naval Postgraduate School, Monterey, Calif. (USA)). Jun 1975. 105p. NTIS $5.25.

Thesis.

A method is presented for determining the relationships between the costs and technical performance of environmental vapor power systems in a manner which permits fundamental design specifications to be made optimally with respect to overall system lifetime costs. Means of applying optimization techniques for large scale systems to the thermoeconomic analysis of environmental vapor power systems are described and demonstrated with a simplified sample model. A sequential unconstrained minimization algorithm is employed for overall system design optimization. (auth)

ENVIRONMENTAL ASPECTS

4684 (PB—239402) **Diurnal temperature distribution in small reservoir. Final report.** Armaly, B.F. (Missouri Univ., Rolla (USA)). 17 Jan 1975. Contract DI-14-31-0001-4025. 58p. (OWRT-A—080-MO(1)). NTIS $4.25.

The diurnal temperature distribution in a deep water impoundment which is exposed to heating and cooling loads by convection, evaporation, and radiation is examined. The diurnal behavior of the solar load, directional and spectral, is used with the selective attenuation and reflection characteristics of the water to account for the internal solar energy absorption rate. Simple atmospheric and water attenuation models were used to examine and simulate the diurnal behavior. The results demonstrate the stratification developments of the reservoir and indicate that in some cases the deep layer responds continuously to the diurnal fluctuations of surface energy loads. (auth)

SOLAR ENERGY CONVERSION

4685 (NTIS/PS—75/691) **Solar electric power generation (a bibliography with abstracts). Report for 1964—August 1975.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). Sep 1975. 149p. NTIS $25.00.

Abstracts pertaining to terrestrial electric power generation by both direct conversion with solar cells and indirect conversion using solar heat are presented. Included are abstracts dealing with solar sea power. Topic areas cover equipment design, site surveys, and feasibility studies. (NTIS)

4686 (PB—242898) **Solar thermal conversion mission analysis. Volume I. Summary report: southwestern United states.** (Aerospace Corp., El Segundo, Calif. (USA)). Jan 1975. Contract NSF-C797. 212p. (ATR—74(7417-16)-2-VOL-1; NSF/RA/N—74-205A). NTIS $7.25.

The principal results of the solar thermal conversion mission analysis applied to the southwestern United States are presented. The mission analysis methodology was applied on a consistent basis to the evaluation of alternative solar thermal conversion concepts for providing electrical power under realistic operating environments. Based upon the comparative technical and economic evaluation of the alternative concepts, preferred concepts were identified and technical and economic goals defined for these concepts. Subsequently, a preliminary market capture potential was made for the preferred systems. (NTIS)

4687 (PB—242901) **Solar thermal conversion mission analysis. Volume IV. Southwestern United States. Comparative**

systems/economics. (Aerospace Corp., El Segundo, Calif. (USA)). 15 Nov 1974. Contract NSF-C797. 247p. (ATR—74(7417-16)-1-VOL-4; NSF/RA/N—74-205D). NTIS $9.50.

Results of the comparative analyses conducted in evaluating the technical and economic performance of alternative solar thermal conversion concepts are described. The report is divided into five sections: a comparative technical evaluation, a margin analysis, a comparative economic evaluation, preferred system selection and definition, and environmental impact and market capture potential. (NTIS)

4688 **Photochemical solar energy conversion.** Harrigan, R.W. (Sandia Labs., Albuquerque, NM). pp 141 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

PHOTOVOLTAIC CONVERSION

4689 (AD/A—002846) **Integral glass covers for silicon solar cells. Final technical report, 19 May 1971—31 October 1974.** Rauch, H.W. Sr.; Ulrich, D.R. (General Electric Co., Philadelphia, Pa. (USA). Space Div.). 31 Oct 1974. Contract F33615-71-C-1656. 70p. NTIS $4.25.

A program of inorganic glass development resulting in the formulation of numerous compositions for direct fusion to silicon solar cells was conducted. The glasses were sedimented as -200 mesh particles onto the front surface of the solar cells, then fused, to form an integral cover, at temperatures ranging from 510C to 600C depending on solar cell type and glass composition. Coatings, at least 50 microns thick, were applied to both N/P aluminum-contacted and silver/titanium-contacted cells. Electrical characterization of the bare and coated cells, before and after electron irradiation, shows that some cells can be integrally covered by this technique without degrading their conversion efficiency below an acceptable level. Glass preparation, compositional modifications, and the effect of these changes on fusion temperature, radiation resistance, transmission, and thermal expansion are discussed. (GRA)

4690 (AD/A—008783) **Exploratory development of transparent conductor materials. Final report.** Haacke, G. (American Cyanamid Co., Stamford, Conn.). Mar 1975. Contract F33615-74-C-5021. 64p. NTIS $4.25.

The development of electrically conductive cadmium stannate coatings with high visible transparency and high infrared reflectivity has been pursued. Efforts concentrated on the investigation of different deposition technologies, film doping, coating of various substrate materials, and film testing. One of the major applications of this research is to develop coatings for solar cells. Chemical spray deposition and vacuum evaporation of cadmium stannate films has been evaluated and compared to radio frequency sputtering. Doping experiments showed that interstitial cadmium and oxygen vacancies are effective dopants for maximum electrical conductivities. Indium and tantalum doping increase the infrared reflectivity to 90 percent beyond two micron. Substrate materials investigated included silica, sapphire, soda-lime glass, Chemcor glass, alumina-silica glass, stretched acrylic, and polycarbonate. (GRA)

4691 (AD/A—015380) **Materials Research Laboratory annual technical report, July 1, 1973—June 30, 1974.** (Brown Univ., Providence, R.I. (USA)). 30 Jun 1974. 127p. NTIS $5.75.

Contents: microscopic and macroscopic dynamic plasticity; fracture of solids; inorganic glasses; chemisorption on metallic surfaces; chalcogenide materials; alloy design and synthesis of microstructures for specific properties; plasmas in solids; low temperature properties of materials; pseudo-one-dimensional conductors; general studies of mechanical properties; materials for solar cells; optical properties; magnetic properties. (NTIS)

4692 (AD/A—015880) **Reverse current blocking diodes for flexible solar array protection. Final report, 2 April 1973—14 March 1975.** Levy, E. Jr.; McGrath, R.J. (Hughes Aircraft Co., El Segundo, Calif. (USA)). Apr 1975. Contract F33615-73-C-2060. 247p. (AFAPL-TR—75-23). NTIS $7.00.

A unique solar cell blocking diode for use on solar panels is described. The device has the physical characteristics of a solar cell and the electrical properties of conventional diodes currently used for solar array reverse current isolation and protection. This combination of physical characteristics and electrical properties permits mounting of the diode on the panel surface in series with solar cells, and is particularly useful for flexible rollup solar arrays. The diode junction is diffused into a 1 x 2 cm, 8 mil thick, p-doped silicon blank. Nominal inverse voltage standoff characteristics of 140 volts at 1 mA leakage have been achieved with 20 Ohm-cm base resistivity, 6 micrometer diffused junctions, and heavy silicon monoxide layers for surface passivation. Typical forward voltage drop at 0.3/3.0 Amperes are of the order of 0.8/1.2 Volts. Conventional diodes exhibit nominal inverse voltage standoff characteristics of 100 Volts at 25 microAmperes leakage, and typical forward voltage drop of 0.8/1.0 Volt at 0.3/3.0 Amperes. (auth)

4693 (CRN-CNPA—75-8) **Increase of the barrier height of silicon solar cells.** Ponpon, J.P.; Siffert, P. (Centre National de la Recherche Scientifique, 67 - Strasbourg (France). Centre de Recherches Nucleaires). 1975. 10p. (In French). INIS.

The efficiency of Schottky silicon solar cells depends strongly upon the barrier height of the metal-semiconductor contact. Increasing this barrier height up to about 1 eV is possible as shown here, either by use of hafnium contacts on P type silicon, or by making an ion implantation before the realization of a gold Schottky diode on N type silicon. (FR)

4694 (ERDA/JPL—954344-75/1) **Web-dendritic ribbon growth. USC solar report No. Q-1. Quarterly report, October 1, 1975—December 31, 1975.** Hilborn, R.B. Jr.; Faust, J.W. Jr. (South Carolina Univ., Columbia (USA). Coll. of Engineering). 1975. Contract 954344. 43p. Dep. NTIS $4.00.

For Jet Propulsion Lab., Pasadena, CA.

This is a report of the first quarter's work on the web-dendritic ribbon growth at the University of South Carolina. A brief description of the work initiated and carried out during this period to meet the program goals is given along with a copy of the Program Plan covering the entire period of the contract. (auth)

4695 (LBL—3985) **Investigation of the Cu/sub x/S/Cd/sub 1-y/ZnyS heterojunction: potentially low-cost, high-efficiency photovoltaic energy converter.** Peterson, T.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-eng-48. 75p. Dep. NTIS $5.50.

Thesis.

Heterojunction photovoltaic cells of cuprous sulfide and cadmium—zinc sulfide ($Cd_{0.75}Zn_{0.25}S$) were made by dipping single crystal cadmium—zinc sulfide in an aqueous Cu^{+} solution. For purposes of comparison, cells were also made of cuprous sulfide on single crystal cadmium sulfide and zinc sulfide. The cadmium—zinc sulfide, "mixed crystal," cells' properties were found to be superior to the CdS cells' in all respects, except short-circuit current density. In particular, they had higher power conversion efficiencies. It is argued that the higher efficiency of the mixed crystal cells together with the likelihood of their having greater stability than the CdS cell (because of lower copper diffusivity) makes them an attractive alternative to other photovoltaic cells for economical solar power conversion. A theoretical model of the cuprous sulfide/II-VI semiconductor heterojunction is developed. The model is an extension of currently accepted models of such junctions incorporating explanations of (1) enhancement/quenching data found in two-beam experiments in terms of the rigid-band model of cuprous sulfide first proposed by Mulder; (2) the decrease in short-circuit current in djurleite-CdS cells, as compared to chalcocite-CdS cells, in terms of the movement of dislocation arrays required for lattice mismatch accommodation; and (3) the change in barrier height and spectral response of cuprous sulfide-Cd/sub 1-y/Zn/sub y/S heterojunctions, as the zinc fraction is increased, in terms of the change in electron affinity of the II-VI compound. (auth)

4696 (N—75-15585) **Irradiation and measurement of fluorinated ethylene-propylene-a on silicon solar cells in vacuum.** Marsik, S.J.; Broder, J.D. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Jan 1975. 12p. (NASA-TM-X—3189; E—8109). NTIS $3.25.

Silicon monoxide (SiO) coated silicon solar cells covered with fluorinated ethylene-propylene-A (FEP-A) were irradiated by 1-MeV electrons in vacuum. The effect of irradiation on the light transmittance of FEP-A was checked by measuring the short-circuit current of the cells while in vacuum after each dose increment, immediately after the irradiation, and again after a minimum elapsed time of 16 hr. The results indicated no apparent loss in transmission due to irradiation of FEP-A and no delamination from the SiO surface while the cells were in vacuum, but embrittlement of FEP-A occurred at the accumulated dose. (auth)

4697 (NASA-CR—120483) **Solar array technology evaluation program for SEPS (Solar Electrical Propulsion Stage).** (Lockheed Missiles and Space Co., Sunnyvale, Calif. (USA)). Sep 1974. Contract NAS8-30315. vp. NTIS.

An evaluation of the technology and the development of a preliminary design for a 25 kw solar array system for solar electric

propulsion are discussed. The solar array has a power to weight ratio of 65 w/kg. The system is composed of two wings. Each wing consists of a solar array blanket, a blanket launch storage container, an extension/retraction mast assembly, a blanket tensioning system, an array electrical harness, and hardware for supporting the system for launch and in the operating position. (WDM)

4698 (NASA-CR—140842) **Power processor design considerations for a solar electric propulsion spacecraft.** Costogue, E.N.; Gardner, J.A. (California Inst. of Tech., Pasadena (USA)). Jun 1974. Contract NAS7-100. vp. NTIS.

The propulsion power processor generated the regulated dc voltages and currents from a solar array source of a solar electric propelled spacecraft. It consisted of 12 power supplies that provide the regulated voltages and currents necessary to power 30 cm mercury ion thruster. The design options for processing unregulated solar array power and for generating the regulated power required by each supply are studied. The technical approaches utilized in the developed design and the technological limitation of the identified design options are discussed. (WDM)

4699 (NASA-CR—140843) **Lithium-doped solar cell pilot line fabrication and test programs.** Berman, P.A.; Yasui, R.K. (California Inst. of Tech., Pasadena (USA)). Oct 1974. Contract NAS7-100. vp. NTIS.

An investigation was conducted to determine the technology readiness of lithium-doped silicon solar cells with respect to use in space programs. A pilot line fabrication program was established, in which the pilot line cells were evaluated after being exposed to environments ordinarily imposed on nonlithium-doped silicon solar cells. Results indicate that further process improvements are required particularly with respect to the P/N junction diffusion and the electrical contacting technique (including solder coating). It is concluded that lithium-doped cells can be fabricated to exhibit high efficiencies, uniform cell-to-cell recovery characteristics after exposure to 1-MeV electrons, and good stability in most environments investigated (the only exception being the thermal shock environment). (WDM)

4700 (NTIS/PS—75/477) **Chemical vapor deposition (a bibliography with abstracts). Report for 1964—May 1975.** Lehmann, E.J. (National Technical Information Service, Springfield, Va. (USA)). Jun 1975. 216p. NTIS $25.00.

Chemical vapor deposition of ceramics, metals, and glasses are presented in this bibliography of Federally-funded research. The applications include optical coatings, semiconducting films, fiber barrier coatings, solar cell coatings, and protective films. The physical, mechanical, and chemical properties of these coatings are also covered as well as the chemistry and fabrication techniques for materials such as silicon, SiC, SiO2, Boron, GaAs, metal oxides, selenides, titanates, aluminum, and titanium. 211 abstracts. (GRA)

4701 (NTIS/PS—75/692) **Optical coatings for solar cells and solar collectors (a bibliography with abstracts). Search period covered: 1964—August 1975.** Lehmann, E.J. (National Technical Information Service, Springfield, Va. (USA)). 1975. 144p. NTIS $25.00.

Materials and research for the development of selective coatings for solar energy conversion devices are described in these citations of Federally-funded research. These materials include types of coatings or covers used to reflect or transmit solar radiation in order to optimize solar conversion to heat or electricity. Also presented is research on covers or coatings which protect against thermal, radiation, or environmental damage. 89 abstracts. (auth)

4702 (NTIS/PS—75/693) **Cadmium sulfide solar cells (a bibliography with abstracts). Period covered: 1964—August 1975.** Smith, M.F. (National Technical Information Service, Springfield, Va. (USA)). Sep 1975. 225p. NTIS $25.00.

The citations cover cadmium sulfide solar cell development and use including their design, theory, fabrication, characteristics and degradation. Contains 181 abstracts. (auth)

4703 **Principles and applications of selective solar coatings.** Jurisson, J.; Peterson, R.E.; Mar, H.Y.B. (Honeywell, Inc., Systems and Research Center, 2600 Ridgway Parkway, Minneapolis, Minnesota 55413). *J. Vac. Sci. Technol.*; 12: No. 5, 1010-1015(Sep 1975).

Several ways that selective coatings can be used to enhance the performance of solar energy collection systems are reviewed. Coatings discussed include vacuum-deposited, electroplated, and paint-type selective solar absorber coatings and vacuum-deposited and chemically etched antireflection and infrared reflecting coatings for glass. The optical and physical requirements for the coatings, as well as their effectiveness at increasing solar collector performance, are discussed.

4704 (PB—234565) **Research applied to solar-thermal power systems. Chemical vapor deposition research for fabrication of solar energy convertors. Annual progress report, 1 January—31 December 1973.** Seraphin, B.O. (Arizona Univ., Tucson (USA). Optical Sciences Center). 31 Jan 1974. 95p. NTIS $4.00.

The project supports research on a new approach to a selective solar energy convertor that can be used to transform solar radiation into high temperature heat. This heat can be transferred and applied in a steam turbine-generator unit to produce electricity. The selective solar energy convertor is basically a two-layered construction in which the top layer is a semiconductor material, such as silicon, having high absorption for solar radiation and high transparency for blackbody radiation from the heated unit. The bottom layer is a metal film having high reflectance. (GRA)

4705 (PB—235347) **Applied research on II—VI compound materials for heterojunction solar cells. Semiannual progress report, 1 January—30 June 1974.** Bube, R.H. (Stanford Univ., Calif. (USA). Dept. of Materials Science and Engineering). Jul 1974. 49p. NTIS $3.75.

p-CdTe, n-CdS solar cells have been prepared both by a close-spaced vapor transport of CdTe onto single crystal CdS, and by vacuum evaporation of CdS onto single crystal CdTe, with measured solar efficiencies at AM1 of 3-4 percent. These cells compare favorably with p-Cu2S, n-CdS cells. Perhaps the highest efficiency II-VI heterojunction cell would be p-CdTe, n-Zn(0.35)Cd(0.65)S. The most critical parameter in making actual cells approach theoretical values is control of the reverse saturation current, which typically is some 10,000 times larger than the theoretical value for a simple junction. All-film cells with an efficiency of 5-10 percent are the present goal of the work. (GRA)

4706 (PB—235481) **Chemical vapor deposition research for fabrication of solar energy convertors. Quarterly progress report, 1 January—31 March 1974.** Seraphin, B.O. (Arizona Univ., Tucson (USA). Optical Sciences Center). 30 Apr 1974. 47p. NTIS $3.25.

The project will support research on a new approach to a selective solar energy convertor that can be used to transform solar radiation into high temperature heat. The selective solar energy convertor is basically a two-layered construction in which the top layer is a semiconductor material, such as silicon, having high absorption for solar radiation and high transparency for blackbody radiation from the heated unit. The bottom layer is a metal film having high reflectance. (GRA)

4707 (PB—236189) **Chemical vapor deposition research for fabrication of solar energy convertors. Semiannual progress report, 1 January—30 June 1974.** Seraphin, B.O. (Arizona Univ., Tucson (USA). Optical Sciences Center). 15 Aug 1974. 78p. NTIS $4.75.

This project supports research on a new approach to a selective solar energy convertor that can be used to transform solar radiation into high temperature heat. The selective solar energy convertor is basically a two-layered construction in which the top layer is a semiconductor material, such as silicon, having high absorption for solar radiation and high transparency for blackbody radiation from the heated unit. The bottom layer is a metal film having high reflectance. A chromium oxide layer on top of the stainless steel substrate reduces the effects of a mismatch of thermal expansion and inhibits interaction between substrate and multilayer stack. This report describes the successful transfer of the previously developed technology to stainless steel substrates. Several hundred temperature cycles of the stack up to 500C did not induce detrimental effects. Changes in the optical characteristic of the stacks at 500C do not lead to a degradation of the optical performance. (GRA)

4708 (PB—236193) **Direct solar energy conversion for large scale terrestrial use. Interim report, 1 January—30 June 1974.** (Delaware Univ., Newark (USA)). 5 Jul 1974. 97p. NTIS $4.75.

Good process control is reported for all steps in the production of Cu_2S/CdS solar cells. This has resulted in highly reproducible cell performance permitting controlled study of the influence of individual parameters such as etching, barriering, etc. Accelerated life testing continues to substantiate previous estimates of usable life at approximately 50°C in excess of 15 years. Cell regeneration experiments are giving positive results. Auger spectroscopy and energy scanning x-ray diffraction results show that high cell performance is related to a high Cu:S ratio in the copper sulfide layer and a critical thickness range. Degradation is associated with a reduction in this ratio and ultimately the production of copper oxides. Information on the characteristics and depth of the depleted layer in CdS have been obtained using capacitance measurements. Theoretical studies have continued in the analysis of parameters controlling the light generated current and the diode parameters. (NTIS)

4709 (PB—238947) **Chemical vapor deposition research for fabrication of solar energy convertors. Quarterly report No. 3, 1 July—30 September 1974.** Seraphin, B.O. (Arizona Univ., Tucson (USA). Optical Sciences Center). 28 Oct 1974. 41p. NTIS $3.75.

A selective solar energy convertor that can be used to transform solar radiation into high temperature heat is discussed. It is basically a two-layered construction in which the top layer is a semiconductor material, such as silicon, having high absorption for solar radiation and high transparency for blackbody radiation from the heated unit. The bottom layer is a metal film having high reflectance. This report describes the completion of the entire stack, including an antireflection coating of silicon nitride. (GRA)

4710 (PB—239184) **Applied research on II—VI compound materials. Quarterly progress report, 1 July—30 September 1974 for heterojunction solar cells.** Bube, R.H.; Fahrenbruch, A.; Buch, F.; Mitchell, K. (Stanford Univ., Calif. (USA). Dept. of Materials Science and Engineering). Oct 1974. 41p. NTIS $3.75.

Development of p-CdTe/n-CdS heterojunction solar cells has been facilitated by improvements in experimental apparatus, design and construction of new apparatus, and evaluation of films and cells made by both the close-spaced vapor transport (CSVT) method, and by vacuum evaporation. CdTe films have been deposited by CSVT on single crystal Cds and on bulk and evaporated Ni; CdS films have been deposited by CSVT on quartz and have been made low resistivity by suitable heat treatment. A detailed investigation of the effects of heat treatment on evaporated CdS film on single crystal CdTe cells provides a number of insights into transport mechanisms at the junction; the reverse saturation current is caused by tunneling rather than by simple recombination-generation processes. Useful insights are anticipated from the preparation and properties of p-ZnTe/n-CdSe cells. Improvements in electrical contact to p-CdTe are being sought through ion-implantation of P acceptors. (GRA)

4711 (PB—239270) **Symposium on the material science aspects of thin film systems for solar energy conversion held at Tucson, Arizona, on May 20—22, 1974.** Seraphin, B.O. (Arizona Univ., Tucson (USA). Optical Sciences Center). Jul 1974. 441p. NTIS $11.25.

The objective of this symposium is to disseminate the latest results in thin-film technology associated with solar thermal coatings and photovoltaics to interested university, industrial, and governmental research personnel. The series of invited papers, discussions, and panel sessions have been structured to: (a) bring together experts knowledgeable in fields representating relevant aspects of solar energy conversion, (b) discuss with representatives from relevant industries the problems encountered and the efforts to solve them, and (c) complement the university efforts with the experience from industrial laboratories. (GRA)

4712 (PB—239280) **Development of 20 percent efficient solar cell. Quarterly progress report No. 3, 1 June—30 September 1974.** Lindmayer, J. (Solarex Corp., Rockville, Md. (USA)). Oct 1974. 30p. NTIS $3.75.

During this reporting period, primarily the n-p cell was studied. The front junction formation was mapped using phosphorus and, in some cases, arsenic diffusion. As a result, good junction with high fill factors (sharpness of the junction) could be obtained in the temperature range 850-870°C. As will be detailed, a large variety of materials were used on the back surface for the purpose of blocking rear diffusion and to determine their n-type or p-type character. The listing appearing in the report is merely qualitative grouping, as each system represents a complex metallurgical, physical-chemical system. Considering the fact that the index of retraction of silicon is relatively high, some optical coupling arrangement is required to reduce the attendant reflection. The reporting period also includes preparation for solar electric experiments to be carried out in Antarctica. (GRA)

4713 (PB—239282) **Glass—Si heterojunction solar cells. Quarterly report No. 3, 1 August—30 September 1974.** Anderson, R.L.; Kent, G.; Lai, S. (Syracuse Univ., N.Y. (USA)). Oct 1974. 3p. NTIS $3.75.

The purpose of this project is to investigate the feasibility of fabricating low-cost solar cells suitable for terrestrial application. These cells consist of glass-silicon heterojunctions. Specific goals include the preparation and characterization of glass-monocrystalline Si and glass-polycrystalline Si heterojunctions, and modeling of these devices. Heterojunction solar cells comprised of p-type semiconducting glass on n-type Si and n-type semiconducting glass on p-type Si are investigated. The glass acts as an integral part of the heterojunction, but is transparent to solar radiation, thus permitting the radiation to penetrate to the junction transition region. It also acts as a low resistance contact and as an antireflection coating. Although efforts at making p-glass/n Si cells have been unsuccessful to date, n-glass/p Si cells have been fabricated. These have short circuit currents of 40 ma/sq cm, open circuit voltages of 0.3 volts, and conversion efficiencies (AMI) of 5 percent. (GRA)

4714 (PB—239372) **Research on cadmium stannate selective optical films for solar energy applications. Quarterly report No. 3, 1 July—30 September 1974.** Haacke, G. (American Cyanamid Co., Stamford, Conn.). Oct 1974. NTIS $3.75.

The development of transparent and conductive cadmium stannate coatings was pursued with emphasis on the preparation of single phase film specimens. Efforts to prevent the formation of unwanted phases during deposition concentrated on adapting the bias sputtering technique to the cadmium stannate film preparation. Although the deposition parameters involved have not yet been optimized, improved optical transmission characteristics were observed in some of the bias sputtered samples. (GRA)

4715 (PB—240910) **Solar silicon definition. Progress report, 15 October —31 December 1974.** Wakefield, G.F.; Chu, T.L.; Blair, J.W.; Brown, G.A.; Harrap, V. (Texas Instruments, Inc., Dallas (USA)). 20 Feb 1975. 50p. NTIS $3.75.

The objective of this project is to determine the optimum silicon quality for cost-effective solar cells suitable for large-scale terrestrial utilization. The effects of selective impurities upon the solar cell performance was investigated by preparation and characterization of a matrix of silicon samples. Evaluation of the i-v curves to obtain the slope of the forward current of simple p-n junctions provided rapid material evaluation. Several iterations of matrix level redefinition, sample preparation, and reevaluation are required to establish maximum impurity tolerance. Experimental techniques have been demonstrated for achieving reliable data. Preliminary results indicate a substantially higher tolerance level for most elements compared to semiconductor silicon requirements. (auth)

4716 (PB—241007) **Direct solar energy conversion for large scale terrestrial use. Annual report, 1 January—31 December 1974.** Boer, K.W. (Delaware Univ., Newark (USA). Inst. of Energy Conversion). Jan 1975. 170p. (NSF/RA/N—75-013). NTIS $6.25.

Work is proceeding related to all major aspects of the Cu_2S/CdS solar cell. Results are reported in the following areas: (1) cell production—cells of conversion efficiency of 5 percent can be fabricated reproducably on substrates of zinc-plated copper and molybdenum.Experimental technique pertaining to salient fabrication steps are presented. (2) Cell structural analysis—work reported here includes Auger, Rutherford backscattering and energy dispersive x-ray analysis, grain boundary and diffusion length studies, and Cu_2S synthesis. (3) Cell electrical analysis—major results related to diode analysis, spectral response, solar simulation, response uniformity and junction capacitance are discussed. (4) Cell lifetime studies—life testing (accelerated and rooftop) and degradation results are presented. (5) Theoretical studies—details related to diode and light generated currents and the heterojunction model are reported. (auth)

4717 (PB—242529) **Photovoltaic conversion of solar energy for terrestrial applications. Executive report of workshop conference held at Cherry Hill, New Jersey on October 23—25, 1973.** Lutwack, R. (Jet Propulsion Lab., Pasadena, Calif. (USA)). 15 Oct 1974. 62p. (JPL-SP—43-12; NSF/RA/N—74-073). NTIS $4.25.

A general overview of the workshop proceedings deals primarily with the sections which treat the problems of using photovoltaic conversion devices for terrestrial applications. Topic areas covered include: single-crystal Si solar cell; CdS/Cu_2S solar cell; other materials and devices: insolation, testing and evaluation, and systems. (auth)

4718 (PB—243810) **Development of low-cost thin film polycrystalline silicon solar cells for terrestrial applications. Semiannual progress report, 1 January—30 June 1975.** Chu, T.L. (Southern Methodist Univ., Dallas, Tex. (USA)). Jul 1975. 59p. (NSF/RA/N—75-048). NTIS $4.25.

With the objective of developing low-cost, thin film, polycrystalline silicon solar cells suitable for large-scale terrestrial utilization, silicon was deposited on carbon/graphite substrates, and on graphite substrates. The microstructure, crystallographic properties, and solar cell characteristics were studied. A zone-melting technique has been developed for the recrystallization of silicon on graphite substrates. Silicon solar cells with AmO efficiencies up to 2.5 percent have been produced. The grain boundary effects in silicon solar cells of the configuration N(+)/P/cast metallurgical-grade silicon were reduced by increasing the Dopant concentration in the p-layer, and AmO efficiencies up to 3.5 percent were obtained. Solar cells deposited on Czochralski polycrystalline metallurgical silicon substrates had higher efficiencies, about 4.2 percent. Metallurgical silicon has been purified by the chemical treatment of the melt and float-zone refining. Solar cells with AmO ef-

ficiencies of about 4.5 percent were obtained from two-zone pass material. (NTIS)

4719 (SAND—75-5730) **Numerical analysis of back-surface-field silicon solar cells.** Fossum, J.G. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 4p. (CONF-751206—2). Dep. NTIS $4.50.

From IEEE international electron devices meeting; Washington, District of Columbia, USA (1 Dec 1975).

A proven semiconductor device analysis computer code was used to numerically simulate back-surface-field silicon solar cells. The insight afforded by the one-dimensional solutions of carrier transport in these cells enabled the identification of pertinent physics describing the operation of these devices. With this analytical knowledge, discussions concerning the essential properties of an effective BSF solar cell are presented. The practicality of using silicon BSF cells for terrestrial applications, specifically in high-temperature, multiple-sun environments, was examined through the use of the device analysis code. The results of this study are encouraging and suggest that the highest-efficiency, most economical solar cells of the future may well be high-resistivity back-surface-field silicon cells. (auth)

4720 (TID—26871) **Interim solar cell testing procedures for terrestrial applications.** Brandhorst, H.; Hickey, J.; Curtis, H.; Ralph, E. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center; Energy Research and Development Administration, Washington, D.C. (USA). Div. of Solar Energy). Jul 1975. 18p. Dep. NTIS $4.50.

This report presents an interim draft of procedures for testing solar cells for terrestrial applications that resulted from the terrestrial photovoltaic workshop sessions. A final version of the test procedures manual is planned for the summer of 1976. (WDM)

4721 **Solar cell assembly.** Brandhorst, H.W. Jr. (to Lewis Research Center). US Patent Application 510,677. 30 Sep 1974. 13p.

An improved solar cell assembly is provided for use under high intensity illumination conditions where heat is a problem. The solar cell assembly includes a solar cell with an overlay of a semi-transparent coating of a metal such as aluminum or silver, which covers the entire surface. The purpose of the coating is to lower the amount of incident radiation on the cell and thereby lower cell temperature. Use of the semi-transparent coating over the entire cell surface uniformly limits incident radiation and hence reduces cell heat without any temperature gradients. The coating also lowers series cell resistance. The coating may be directly deposited on the cell surface or on the undersurface of cover plate bonded to the cell.

4722 **Design optimization of silicon solar cells for high illumination intensity.** Bartels, F.T.C. (SPECTROLAB, Inc., Sylmar, CA). pp 116-117 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4723 **Improved silicon solar cells on graphite substrates.** Chu, T.L.; Mollenkopf, H.C.; Chu, S.S.; Wu, I.C. (Southern Methodist Univ., Dallas). pp 122-123 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4724 **Cd/Cu_2S solar cells for large scale terrestrial applications.** Boer, K.W.; Burton, L.; Hadley, H.; Phillips, J.; Rothwarf, A.; Storti, G.; Windawi, H. (Univ. of Delaware, Newark). pp 126-127 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4725 **Reliability of low cost Cu_2S/CdS solar cells for large scale conversion of solar to electrical energy.** Partain, L.D.; Sayed, M.M. (Univ. of Delaware, Newark). pp 45-55 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Large scale conversion of solar to electrical energy at low cost is possible using high efficiency, high reliability Cu_2S/CdS solar cells. Low cost fabrication involves relatively simple processes consuming small amounts of material. Accelerated life tests give extrapolated lifetime in excess of twenty years. The probable decay mechanisms are thermal diffusion, formation of recombination centers, and voltage induced decomposition. (auth)

4726 **CdS/Cu_2S solar cells: their potential and limitations.** Boer, K.W.; Hadley, H.C. Jr.; Phillips, J.E.; Rothwarf, A. (Univ. of Delaware, Newark). pp 387-391 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

A review is given of typical CdS/Cu_2S solar cells, the physics of the cell operation and possible limiting factors. Indications are given for the potential of these cells in respect to possible conversion efficiencies (in excess of 15 percent), life expectancies (in excess of 20 years), and production yields (in excess of 90 percent, within a 1 percent efficiency band). (auth)

4727 **Life expectancy of CdS/Cu_2S solar cells on terrestrial surfaces.** Windawi, H.M. (Univ. of Delaware, Newark). pp 392-395 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The use of CdS/Cu_2S solar cells for the conversion of sunlight into electricity has been and continues to be evaluated on the roof of Solar One, the Delaware solar house and the roof of the Institute of Energy Conversion, University of Delaware. The performance of CdS/Cu_2S solar cell series-array panels under roof-top conditions of insolation and temperature is analyzed. No overall degradation has been observed. However, seasonal variations are found in panel output and are correlated with insolation parameters. (auth)

4728 **New type of Cu_2S/CdS backwall solar cell.** Burton, L.C. (Univ. of Delaware, Newark); Haacke, G. pp 396-399 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Cu_2S/CdS solar cells constructed on cadmium stannate/quartz substrates have yielded backwall conversion efficiencies over 5 percent under AMl rooftop conditions. The cadmium stannate/quartz substrate results in good CdS adherence and ohmic contact, with a cell series resistance of 1.5 ohms resulting. The use of a reflecting surface placed behind the cell results in a considerable increase in short circuit current. (auth)

4729 **Design considerations in Schottky solar cells.** Anderson, W.A.; Delahoy, A.E.; Vernon, S.M. (Rutgers-The State Univ., New Brunswick, NJ). pp 400-403 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Schottky solar cells have been fabricated using Cr Schottky metal on p-type silicon. AMl sunlight efficiency of 6 to 9.5 percent has been measured on 1 to 3 cm^2 area cells. Computer studies predict a quantum efficiency of 0.71 for the Schottky cell which compares well to experimental data from 0.35 to 1.1 μ. Increased temperature decreases open circuit voltage by 2.5 mV/°C and fill factor by 0.4 percent/°C similar to previously published data on p-n silicon cells. Performance degradation with temperature cycling to 120°C has not been detected. Proper contact design and a 20 OMEGA/square Schottky metal sheet resistance produce a 0.21 OMEGA total resistance for a 4-finger cell. (auth)

THERMIONIC CONVERSION

4730 (TEE—3056-2) **Summary report on oxygen additives.** Gunther, B.; Lieb, D.; Richmond, C.; Rufeh, F. (Thermo Electron Corp., Waltham, Mass. (USA)). May 1974. Contract AT(11-1)-3056. 152p. (TE—4166-6-74). Dep. NTIS $10.75.

It has been shown repeatedly that minute quantities of oxygen in thermionic converters cause a substantial improvement in performance. The work presented in this report has been guided by experimental data obtained over the last decade from converters which have shown additive effects without any intentional efforts to introduce additives into the converters. (WDM)

PHOTOSYNTHETIC CONVERSION

4731 (PB—238545) **Technology for the conversion of solar energy to fuel gas. Quarterly report.** (National Center for Energy Management and Power, Philadelphia, Pa. (USA)). 30 Apr 1973. 25p. NTIS $3.25.

Research conducted on the "Technology for the Conversion of Solar Energy to Fuel Gas" is described. Emphasis has been based on the need to improve digester technology. Consequently, the development of increased laboratory-scale digester capacity has been stressed. The research program has resulted in the establishment of sufficiently active and stably operating digester cultures to allow initiation of the experimental effort. The primary direction of this effort will be toward the achievement of two-stage digestion. (auth)

4732 **Energy from agriculture.** Alich, J.A. Jr.; Inman, R.E. (Stanford Research Inst., Menlo Park, CA). pp 834-841 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The types of vegetation best suited for an intensive energy plantation as well as vegetation selection criteria are discussed. The type and availability of land for, as well as logistics and economics of, growing energy crops on a conceptual terrestrial plantation are discussed. An energy budget for plant material production and harvesting for the conceptual plantation is developed. A technoeconomic comparison of firing the crops directly for electric power generation with converting them to clean fuel gas (methane or low-Btu gas) either at the farm site or at selected markets is made. (auth)

PHOTOVOLTAIC POWER PLANTS

4733 (PB—238506) **Terrestrial photovoltaic power systems with sunlight concentration. Quarterly report, 1 July—30 September 1974.** Backus, C.E. (Arizona State Univ., Tempe (USA)). Oct 1974. 52p. NTIS $4.25.

A program was initiated to investigate the basic parametric relationships inherent in a solar system that concentrates sunlight onto solar cells. These relationships can then be used to determine the optimum combination of components that minimize the cost per watt of these systems. Work has progressed in each of the six study tasks: solar cell design, solar concentrator, heat rejection, solar tracker, systems analysis. Specific progress includes: analytic model to characterize cell performance, construction of high irradiance cells, assembly of equipment for high irradiance testing, experiments for empirical evaluation of cell mounting interface, completion of heat rejection model for passive and active cooling of solar cell array, development of insolation and ambient weather model, heat transfer analysis for non-uniform illumination on solar cell array, compilation of heat transfer coefficients for various finned surfaces with passive cooling, and methodology for systems simulation model including cost analysis. (GRA)

4734 **Cost studies on terrestrial photovoltaic power systems with sunlight concentration.** Evans, D.L.; Florschuetz, L.W. (Arizona State Univ., Tempe). pp 114-115 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4735 **Is massive solar energy conversion a practical prospect.** Bockris, J.O. (Flinders Univ., Adelaide). pp 9-34 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Seven methods for solar energy to electricity are described; costs per kW and of the derived electricity costs are given. Availability limits the choice of photovoltaics except AlSb or AlSi. Recent technology would reduce silicon based plants to $375 per kW. Electrolysis at site and transport of hydrogen would make far-off sources using two methods economic: desert concentrators with heat engines or ocean thermal gradient collectors. Electricity would be 10 mils per kWh^{-1}; hydrogen $2.23 per 10^6 Btu. (auth)

SOLAR THERMAL POWER PLANTS

4736 (PB—239277) **Proceedings of the solar thermal conversion workshop held in Arlington, Virginia, January 11—12, 1973.** Eckert, E.R.G.; Jordan, R.C.; Sparrow, E.M.; Wehner, G.K.; Ramsey, J.W. (Maryland Univ., College Park (USA). Dept. of Mechanical Engineering). Nov 1974. 135p. NTIS $5.75.

The Solar Thermal Conversion Workshop, held in Arlington, Virginia, on January 11 and 12, 1973, was the first in a series of workshops sponsored by the National Science Foundation/Research Applied to National Needs (NSF/RANN) solar energy program. Participants in the workshop presented and discussed alternative means of collecting and storing solar heat energy to drive boilers of central-station steam-electric power plants. Systems analysis aspects and means of forecasting the costs of solar thermal conversion power plants were included in the presentations. (GRA)

4737 (TID—26888) **Technical and economic assessment of the prospects for electrical power generation by use of solar ponds.** (Bechtel Corp., Los Angeles, Calif. (USA)). Aug 1975. 54p. Dep. NTIS $5.50.

A brief study was conducted to assess the general technical and economic feasibility of using non-converting solar ponds as a means of generating electric power, as proposed in a Battelle Pacific Northwest Laboratories (BNW) report (BNWL-1891). A review of the literature and the BNW report showed that information on the engineering design and cost of such a power plant was fragmentary. To form a basis for this study, a baseline design was conceptualized relying partially on claims published in the literature. Further R and D is required to verify these claims. (WDM)

4738 **Sandia's solar total energy program.** Leonard, J.A. (Sandia Labs., Albuquerque, NM). pp 16-22 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—(Suppl.).

Sandia Laboratories Solar Total Energy program is described. The equipment for a demonstration and test unit is being installed. Total energy is an energy cascading concept in which the normally wasted heat from electrical power generation is used for heating and cooling buildings and for domestic hot water. Sandia uses parabolic trough collectors with receiver tubes at the focus through which a heat transfer fluid (Therminol 66) is pumped at a controlled rate to get a temperature of 310°C in the insulated high temperature storage tank. As required the hot Therminol 66 is drawn from storage to a heat exchanger in which toluene is boiled and superheated. The superheated toluene vapor is expanded through a 32-kW turbine/generator, through a regenerator and back to the heat exchanger. The turbine condenser coolant is collected in a low-temperature storage tank and becomes the energy for space heating and cooling (a lithium bromide absorption machine). Fossil fuel heaters and artificial loads are provided for sunless periods and for engineering test purposes. The equipment is described and control strategies discussed. Future plans are discussed briefly. (LTN)

4739 **Selection and use of energy storage for solar thermal electric application.** Raetz, J.E.; Easton, C.R.; Holl, R.J. (McDonnell Douglas Astronautics Co., Huntington Beach, CA). pp 576-582 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The work done in establishing economic guidelines for candidate energy storage systems is summarized and economically attractive concepts are identified. A baseline system was formulated and its operational characteristics are described. (WDM)

4740 **Fixed mirror solar concentration for electrical generation.** Backus, C.E. (Arizona State Univ., Tempe). pp 601-606 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The fixed mirror solar concentrator (FMSC) is a recent discovery that has a unique geometry that is attractive for solar electric generation systems needing concentration. Its geometry is such that the mirrors can be built in a fixed position and supported directly on the ground. This provides a significant reduction in cost of the collector, which is the dominant cost item in a solar thermal

power plant using steerable collectors. In the FMSC the absorber tube is moved to stay in the focal line which is a sharp focus regardless of the sun's direction. The reflector in the FMSC is a series of long narrow strips of flat mirrors along a cylindrical trough. The faceted nature of this mirror introduces a new loss mechanism of edge losses during reflection. Analysis has shown that the mirror can be designed to have less than 10 percent of the total energy lost over a year's time from these edge losses. The concentration ratio expected in a practical FMSC is about 30 to 50. This amount of concentration reduces the constraints for a highly selective absorber required by lower concentration systems such as the parabolic troughs. This concentration level is also of interest for combining the FMSC with a photovoltaic absorber which could significantly reduce the cost of electricity from solar cells. (auth)

4741 **Continuous duty solar energy system concepts.** Ramakumar, R. (Oklahoma State Univ., Stillwater). pp 759-764 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Two continuous-duty solar energy system concepts are presented in this paper--one for the near term future (1980's) and one for the long term future (1990's and beyond). These systems have evolved as a result of a cumulative research effort at Oklahoma State University, spread over a decade and a half. Technical and economic aspects of these systems are discussed. (auth)

4742 **Solar-energy conversion at high solar intensities.** Backus, C.E. (College of Engineering Sciences, Arizona State University, Tempe, Arizona 85281). *J. Vac. Sci. Technol.*; **12**: No. 5, 1032-1041(Sep 1975).

The concentration of sunlight offers distinct advantages for solar—electrical generation either by thermal conversion or by photovoltaics. A large variety of concentration techniques are available with concentration ratios of 1—1000. Concentration is required for thermal conversion systems to attain the high temperatures needed for efficiencies in the desired range of about 25%—35%. The projected costs for some of the solar thermal systems (especially the central receiver and the fixed mirror) indicate that they could be economically competitive in the southwestern states. The southwest may be required for these high-concentration systems to overcome the main disadvantage of concentration, which is the use of the direct component of sunlight only. Other concerns of high-intensity systems are in tracking requirements, reflective surface accuracy, and material lifetimes of both the reflecting and absorbing components. Selective surface absorbers will be required for systems with concentration ratios below a few hundred. The present high cost of solar-cell-generated electricity can be reduced considerably by using concentrators. Cells can be used with any of the concentrator designs, and the major concern is keeping them at acceptable operating temperatures. Planar silicon cells, vertical multijunction, and gallium—aluminum—arsenide cells all look attractive for concentrating systems.

TOWER FOCUS POWER PLANTS

4743 (PB—243129) **Highlights of the solar thermal conversion program. Semiannual review, 23—24 September 1974.** (Aerospace Corp., El Segundo, Calif. (USA)). Jan 1975. Contract NSF-C933. 50p. (ATR—75(7370)-1; NSF/RA/N—75-039). NTIS $3.75.

This report highlights the results of the solar thermal energy conversion program semi-annual review meeting held at the Martin Marietta Plant in Littleton, Colorado, on 23, 24, and 25 September 1974. The review meeting agenda started with a presentation of progress made in the mission analysis study, followed by the central receiver studies and other research efforts directed at distributed systems, total energy systems, and selective optical coatings. (NTIS)

4744 (PB—243752) **Solar thermal conversion central receiver pilot plant siting.** (Nebraska Univ., Lincoln (USA)). 31 Jan 1975. Contract NSF-C933. 151p. (ATR—75(7370)-3; NSF/RA/N—75/039C). NTIS $6.25.

The results of a study to define siting criteria and identify alternative solar power plant sites for a planned 10 MWe central receiver proof-of-concept experiment (POCE) pilot plant are documented. Technical and institutional criteria were developed and applied to identify twenty potentially suitable general locations. Facilities exist at these locations that could potentially supply logistical support during design, construction, and operation (at some locations) of the POCE. These potentially suitable locations were subsequently examined to assess climatological factors and to identify typical sites within the general area. A total of 29 sites were identified in the six southwestern states of Arizona, California, New Mexico, Nevada, Oklahoma, and Texas. Both favorable and unfavorable climatological features were identified at each site. (NTIS)

4745 (PB—243835) **Solar thermal electric power systems. Volume 1. Executive summary. Final report.** (Colorado State Univ., Fort Collins (USA)). Nov 1974. 49p. (NSF/RA/N—74-196). NTIS $3.75.

The objective of the research program is to develop design parameters of systems for thermal/mechanical coversion of solar energy to electric power at minimum cost per kilowatt-hour generated. Systems of 3 MW to 300 MW sizes in a public utility network are considered. Volume 1 is an executive summary which contains brief summaries of the procedures, results, conclusions and recommendations developed from the study. The three basic plant concepts considered for preliminary evaluation are: (1) A non-focusing collector system using pressurized water at a temperature of 150°C; (2) A line-focusing collector system using steam transport at 250°C; and (3) A multiple tower/heliostat system generating steam at a temperature of 350°C. Sketches of solar thermal power plant configurations and concepts of some components are shown. (NTIS)

4746 (PB—243836) **Solar thermal electric power systems. Volume 2. Systems studies and economic evaluations. Final report.** (Colorado State Univ., Fort Collins (USA)). Nov 1974. 235p. (NSF/RA/N—74-197). NTIS $7.50.

The objective of the research program is to develop design parameters of systems for thermal/mechanical conversion of solar energy to electric power at minimum cost per kilowatt-hour generated. Systems of 3 MW to 300 MW sizes in a public utility network are considered. Parametric performance and cost models are derived for key elements of the systems. A sequential optimization program was developed using these models to determine optimum subsystem sets and combinations which yield the least capital cost plants. A dynamic simulation program was developed to determine annual electric power produced by solar power systems at specific locations. Electric energy cost comparisons are made to select promising systems for generation of electricity from solar energy. Volume 2 titled system studies and economic evaluations, contains descriptions of methodology, parametric performance and cost models, descriptions of solar power plants which have the potential to produce low-cost electric energy, and detailed conclusions and recommendations. (NTIS)

4747 (PB—243837) **Solar thermal electric power systems. Volume 3. Appendices. Final report.** (Colorado State Univ., Fort Collins (USA)). Nov 1974. 639p. (NSF/RA/N—74-198). NTIS $15.25.

The objective of the research program is to develop design parameters of systems for thermal/mechanical conversion of solar energy to electric power at minimum cost per kilowatt-hour generated. Systems of 3 MW to 300 MW sizes in a public utility network are considered. Volume 3, appendices, contains the details of the study which are summarized in volumes 1 and 2. (NTIS)

4748 **Tower-top point focus solar energy collector.** Hildebrandt, A.F.; Vant-Hull, L.L. (Univ. of Houston, TX). pp 35-44 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Temperatures over 1000 C appear possible with a large segmented Fresnel mirror consisting of independent hydraulically or electrically steered heliostats constructed of flat mirrors. In order that the redirected solar radiation from a square mile be intercepted, a central receiver must be elevated well above the mirror field on a tower of about 450 meters height. A square mile collector would produce heat at a peak rate of 500 MWT in the winter and 700 MWT in the summer. (auth)

4749 **Design of a solar cavity steam generator for electrical power generation.** Tracy, T.; Howerton, T. (Martin Marietta Corp., Denver). pp 593-600 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

A preliminary design of a 100,000-kWe solar power plant is described. It consists of eight mirror fields, each of which has 2000 20 x 20-ft heliostats that track the Sun and reflect solar energy into a cavity on a 400-ft tower at the south end of the field. The

cavity has a square opening 20 x 20 ft, a depth of 30 ft, and is about 45 x 45 ft at its maximum dimensions. Superheated steam is produced at 955°F and 1300 psia, which is compatible with economical materials of construction and cyclic operation of the plant. A detailed thermal computer analysis of the cavity was done using programs developed by Martin Marietta for such space programs as Skylab and Viking. The results show an overall thermal efficiency of the cavity of 95 percent. The net plant heat rate is 9780 Btu/kWhr. The overall system design is described, including control concepts and effects of thermal cycling on component design. A model of the cavity, compatible with the French solar test facility capability of 1000 kWt, was designed and analyzed in detail. The design, which ia approximately a 16 percent scale model, is described. Analytical predictions are presented along with a brief description of the testing planned for the summer of 1976 in France. (auth)

LINEAR PARABOLIC POWER PLANTS

4750 (NSF/RANN/SE/GI—34871/PR/75/2) **Research applied to sola thermal power systems. Progress report, January 1, 1975—August 31, 1975.** Sparrow, E.M.; Gupta, B.P.; Wehner, G.K. (Minnesota Univ., Minneapolis (USA); Honeywell, Inc., Minneapolis, Minn. (USA). Systems and Research Center). 30 Sep 1975. 167p. Dep. NTIS $7.75.

Experiments were continued on the scale model parabolic trough collector module at a desert test site. For the tests, the heat pipe absorber tube was coated with a non-selective black paint. The collector efficiency was found to be significantly lower than that of previous experiments conducted with a selectively coated absorber tube. In continuing life tests of candidate solar concentrator surfaces, samples of second surface aluminum and silver mirrors on Acrylic, Teflon, and glass have undergone negligible degradation from exposure periods exceeding two years; Auger Electron Spectroscopy in combination with in situ sputtering was used for determining composition versus depth profiles of different solar absorber coatings. Heat pipe tests relating the effect of inclination angle and materials compatibility were performed. An experimental boiler/heat exchanger, which simulates a component of a solar-thermal collector module, has been operated at 870 psia and 530°F. Measurements were made of the steam and feedwater flow rates as well as of the pressure and temperature in the boiler. Thermal conductivity measurements of insulating materials were performed, with particular emphasis on diminishing radiative transfer at high temperatures. The heat transfer characteristics of phase-change heat storage media were calculated with account being taken of shrinkage. Operational experience has been obtained for experiments on a single-phase (water) heat storage system. (auth)

OCEAN THERMAL GRADIENT POWER PLANTS

4751 (AD/A—015-954) **Ocean thermal energy conversion: a model approach.** Frey, T.W. (United States Naval Academy, Annapolis, Md.). 22 May 1975. 87p. (USNA-TSPR—66). NTIS $4.75.

An ocean thermal energy conversion model was successfully built and it has demonstrated the feasibility of power generation from small temperature differences similar to those existing in the tropical oceans. Seventy watts of electrical power were generated at a pressure difference of .32 psi, corresponding to an 11°F internal temperature differential. The model, the proceedings and details are described in the work. (NTIS)

4752 (AD/A—013561) **Thermoeconomic analysis of vapor power systems. Final report for 1975.** Sheppard, F.L.; Hartman, J.K.; Kelleher, M.D.; Nunn, R.H. (Naval Postgraduate School, Monterey, Calif. (USA)). 30 Jun 1975. 106p. NTIS $5.25.

A method is presented for determining the relationships between the costs and technical performance of vapor power systems in a manner which permits fundamental design specifications to be made optimally with respect to overall system lifetime costs. Means of applying optimization techniques for large scale systems to the thermoeconomic analysis of vapor power systems are described and demonstrated with a simplified sample model. The example studied is an environmentally driven ocean thermal gradient system. A sequential unconstrained minimization algorithm is employed for overall system design optimization. (NTIS)

4753 (APL/JHU-SR—75-2) **Proceedings, third workshop on ocean thermal energy conversion (OTEC), Houston, Texas, May 8—10, 1975. Special reports.** Dugger, G.L. (ed.). (Johns Hopkins Univ., Laurel, Md. (USA). Applied Physics Lab.). Aug 1975. 241p. (CONF-750579—). Dep. NTIS $9.00.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

Thirty-seven papers on the economics, research programs (under way or planned), plant design, power transmission or chemical storage, etc. of solar sea power plants given at the third Workshop on Ocean Thermal Energy Conversion held at Houston, TX on May 8—10, 1975, have been entered individually. (LTN)

4754 (APL/JHU-SR—75-2, pp ix) **Andersons' operating model of the ocean thermal energy conversion principle.** Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

In the model, the warm water heats and vaporizes a working fluid, which then passes through a small turbine to a condenser in an ice bath. The turbine drives a small high frequency alternator and the electricity produced is used to power lights. (LTN)

4755 (APL/JHU-SR—75-2, pp 3-21) **Ocean thermal energy conversion system study report.** Trimble, L.C. (Lockheed Missiles and Space Co., Sunnyvale, CA); Messinger, B.L.; Ulbrich, H.G.; Smith, G.; Lin, T.Y. Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

This Ocean Thermal Energy Conversion (OTEC) study, conducted from July 1974 to April 1975 under the NSF/RANN program, led to the following major conclusions. Solar energy stored in the oceans in the form of a thermal gradient can be tapped. A practical power plant can be built and operated with today's technology. The baseline design developed is a spar-buoy with a telescoping, concrete cold-water pipe reaching a depth of 1500 ft. Four detachable power modules using titanium-tubed heat exchangers generate a total net output of 160 MW(e). With only minor technical improvements, including aluminum coil-panel heat exchangers, energy can be delivered to the busbar at a cost of less than 30 mills/kWh. The plant is designed to operate in severe weather with a life expectancy of 100 years. It is constrained in location to areas of the oceans which provide a temperature differential of approximately 36°F, and is limited in distance from shore by energy transmission systems. This limitation is being investigated separately. The system exhibits a favorable net energy balance; its environmental impact is believed to be acceptable; and it can be used in large sizes and numbers with little chance for catastrophic failure. A low-risk development program can put OTEC power on line by 1986. (auth)

4756 (APL/JHU-SR—75-2, pp 22-38) **Ocean thermal energy conversion: an engineering evaluation.** Douglass, R.H. (TRW, Inc., Redondo Beach, CA). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

The technical feasibility of using the vertical temperature gradient in an ocean to generate electrical power has been established by many investigators. In the present study, the team of TRW, Global Marine, and United Engineers and Constructors has reviewed and analyzed prior work, evaluated key subsystems and components, and synthesized a baseline system concept for a 100-MW(e), closed-Rankine-cycle plant using ammonia as the working fluid. In this baseline concept, a 340-ft-diameter, cylindrical, concrete surface vessel houses four power modules, and a central, cold-water-intake pipe made of fiber-reinforced plastic extends to 4000-ft depth. This plant is designed for use in tropical oceans with a dynamic positioning system that employs the sea-water exhausts from the heat exchangers in shrouded jets. The shell-and-tube heat exchangers have titanium tubes with the ammonia outside the tubes. The estimated baseline system cost is $2100/kW(e), but several approaches for cost reduction (e.g., use of extended-surface, aluminum-tubed heat exchangers outside the hull) are outlined which could reduce the cost to about $1100/kW(e). Needs for research and development, for further investigations of economics, and for a test program are discussed. (auth)

4757 (APL/JHU-SR—75-2, pp 41-44) **Panel discussion of issues raised by system study reports.** Cohen, R.; Avery, W.; Heronemus, W.; Lavi, A.; Anderson, J.H.; Douglass, R.; Trimble, L. Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

The relative merits of open cycle and closed cycle power systems in ocean thermal power plants are discussed. The conclu-

sion is that closed cycle systems involve less risk due to smaller equipment sizes and operating conditions similar to some existing equipment. Open cycle systems involve very large equipment operating at rather unfavorable conditions, but the avoidance of the necessary closed-cycle heat exchangers is an advantage. The importance of heat exchangers in ocean thermal power plants is emphasized, but the authors are not optimistic about greatly improving their efficiency or greatly reducing their cost. Budget problems are discussed. The ocean thermal people do not feel they are getting their fair share of energy research money. Problems of chemical production (ammonia, methanol, hydrogen, etc.) in ocean thermal plants are discussed. (LTN)

4758 (APL/JHU-SR—75-2, pp 47-50) **OTEC program overview.** Cohen, R. (Energy Research and Development Administration, Washington, DC). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

A status report on the national Ocean Thermal Energy Conversion (OTEC) program is presented. Under the National Science Foundation's Research Applied to National Needs (NSF/RANN) program, the OTEC program grew from $84,100 in FY 1972 to $730,700 in FY 1974. In FY 1975, the OTEC program's total funding rose to approximately $3 M, of which approximately $^2/_3$ was transferred to the Division of Solar Energy of the Energy Research and Development Administration (ERDA) upon its formation on January 19, 1975. During the past year, via Program Solicitation NSF 74-9, two awards were made to industrial teams for OTEC system studies (under Category A), and there were twenty smaller awards (under five subcategories of Category B). At this Workshop, reports are being presented on the results of the Category A studies and of other projects, along with summaries of the work planned in the cases of the projects that are just beginning. This paper provides some perspectives regarding current OTEC research and summarizes the goals and tenatative plans of the national OTEC program. (auth)

4759 (APL/JHU-SR—75-2, pp 51-63) **Summary of University of Massachusetts research on Gulf Stream based ocean thermal power plants.** Goss, W.P.; Heronemus, W.E.; Mangarella, P.A.; McGowan, J.G. (Univ. of Massachusetts, Amherst). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

The results of an ongoing analytical study at the University of Massachusetts for the design of major components and a total power system for Gulf-Stream-based ocean thermal plants of 400 MW(e) net power output are presented. The ultimate power potential of a 15-mi-wide by 550-mi-long area of the Gulf Stream resource extending from Charleston, S. C., to the Florida Keys is estimated to be of the order of 2 trillion kWh/yr, which could be transmitted to shore by undersea cables. Critical subsystems and components (such as heat exchangers, cold water inlet pipe, and ocean-based hulls) are identified, and the technical basis for their design and selection is discussed. Plate-fin heat exchangers made of 90:10 Cu—Ni, with propane flowing up (for evaporators) or down (for condensers) through small passages in the plates, and sea water flowing horizontally between the plates, have been selected. The most recent power system configuration (the Mark II design) is a submerged, catamaran configuration; the evaporators are staggered serially in height in six tiers spaced longitudinally above twin concrete hulls, which contain the condensers, pumps, and turbine generators. The 1500-ft-long, 87-ft-hydraulic-diameter (elliptical in cross-section to reduce drag) cold-water-inlet pipe is hinged between the hulls with a gun-buckler type joint. A potential assembly/deployment plan for the plant is summarized. (auth)

4760 (APL/JHU-SR—75-2, pp 64-71) **Solar Sea Power Plants, cost and economics.** Lavi, A. (Carnegie-Mellon Univ., Pittsburgh). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

An attempt is made to reconcile the different cost figures published to date by proponents and evaluators of Solar Sea Power Plants, SSPP's. It is shown that all the variations in the estimated capital cost are basically insignificant and that more reliable estimates can be generated only after certain experiments on heat transfer are carefully conducted and evaluated. It is concluded that at this stage further paper studies are of little value until after these experiments have been completed. (auth)

4761 (APL/JHU-SR—75-2, pp 75-78) **Engineering an open cycle power plant for extracting solar energy from the sea.** Brown, C.E.; Wechsler, L. (Hydronautics, Inc., Laurel, MD). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

The open cycle Ocean Thermal Energy Plant studied includes a heat transfer system utilizing falling film direct contact evaporation and condensation, a large steam turbine, and water pumping systems. Components are sized, the overall plant layout including the supporting platform is described, and cost estimates are presented for a complete system having a 100 MW net output. Capital plant cost is estimated at $450/kW (1975 dollars). (auth)

4762 (APL/JHU-SR—75-2, pp 79-82) **Evaluation of platform designs for ocean thermal power plants.** Barr, R.A. (Hydronautics, Inc., Laurel, MD). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

HYDRONAUTICS, Incorporated is currently negotiating a contract with the Division of Solar Energy of the Energy Research and Development Administration to carry out an analytical evaluation of five candidate platform types for use with ocean thermal power plants. This study will include the effect of the cold water pipe. This report describes these candidate platform types and describes the studies to be carried out. The expected duration of this contract is one year. (auth)

4763 (APL/JHU-SR—75-2, pp 83-85) **Oceanic Institute's OTEC ocean structure scale model project.** Hanson, J.A. (Oceanic Inst., Waimanalo, HI). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

A scale-model testing project for the OTEC ocean structure (here defined as the platform, water pipes, and station-keeping mechanism treated as a system) is described. The work is well under way with support from NOAA's National Sea Grant Program and will be completed in the fall of 1975. Near-real-world conditions are achieved through the use of a natural test tank with wind-driven irregular waves, currents, and winds. The model presently undergoing test is an articulated configuration that can operate both as a surface structure and a semi-submersible. The fundamental question under investigation is—"is the OTEC ocean structure a new species of ocean engineering problem." (auth)

4764 (APL/JHU-SR—75-2, pp 86) **Tuned Sphere Stable Platform: a candidate for OTEC plants.** Mayo, K.E. (Tuned Sphere, International, Nashua, NH). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

A model of the Tuned Sphere Stable Platform, at about 1:70 scale relative to a 100-MW(e) Ocean Thermal Energy Conversion (OTEC) power plant, was built and some preliminary tests of its stability were conducted. A movie was shown which qualitatively illustrated the exceptional stability of this type of vessel. (auth)

4765 (APL/JHU-SR—75-2, pp 87-91) **Operational sea state and design wave criteria, a generalized study for OTEC.** Bretschneider, C.L. (Univ. of Hawaii, Honolulu). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

Project OPSES-DEWAC stands for Operational Sea State and Design Wave Criteria. This study includes the "state-of-the-art" of available information on winds, waves and currents for deep water conditions. The area of the study is limited to the coasts of U.S.A., including Hawaii but not Alaska, and all ocean areas of the world from the equator to 20°S and 20°N latitude. Shallow regions over the continental shelf are excluded in the scope of this project. Thus, such effects as refraction, reflection, bottom friction, breaking wave criteria, etc. are not included in this study. Also, storm surge and tsunami effects are not included. These are conditions that must be evaluated in detail after OTEC site(s) is(are) selected, in particular for design criteria for continental shelf and coastal structures as may be required. It is for these reasons that actual complete statistical analysis of data for any particular potential site will not be included in this study. However, statistical methods for evaluating the data will be

detailed, including a number of examples, in Circular "O" and also in the final report. An example of a proposed circular for Zone 2 is given. (auth)

4766 (APL/JHU-SR—75-2, pp 92) **Cold water pipe: a design feasibility study.** Anderson, J.H.; Anderson, J.H. Jr. (Sea Solar Power, Inc., York, PA). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

The Stockade cold water pipe proposed by Sea Solar Power will be studied. The Stockade pipe is a large pipe made by standing (8 inch diameter) pipes side by side in a ring. A unique joint design coupling the pipe to the hull will be included in the study. The joint has the qualities of not transmitting moments or varying forces between the pipe and hull. (auth)

4767 (APL/JHU-SR—75-2, pp 93-94) **Deep water pipe and mooring study proposal.** Little, T.E. (Westinghouse Electric Corp., Annapolis). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

This research effort will be directed toward conceptual designs and analyses of the cold water pipe, the cold water transport pump, and the plant mooring subsystems for an Ocean Thermal Energy Conversion (OTEC) power plant. The more promising concepts identified will be assessed in terms of their structural characteristics, feasibility of construction and deployment, serviceability, research and development requirements, and cost. (auth)

4768 (APL/JHU-SR—75-2, pp 95-97) **Anchor systems for ocean thermal energy conversion power plants.** Valent, P.J.; Taylor, R.J. (Naval Construction Battalion Center, Port Hueneme, CA). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

Anchor design for moored Ocean Thermal Energy Conversion (OTEC) plants will require an extension of the state-of-the-art in deep-sea-anchor systems because of the difficult combination of environmental conditions (e.g., Gulf-Stream currents), water depth, and large size. This study will provide performance characteristics of existing anchors, estimated performance characteristics of enlarged versions of them, and new concepts to be devised under this study. The capabilities of each anchor will be defined for 5 to 7 seafloor site types that will account for the majority of possible sites for moored OTEC plants. (auth)

4769 (APL/JHU-SR—75-2, pp 98) **Feasibility of submerged concrete structures for OTEC power plants.** Haynes, H.H. (Naval Construction Battalion Center, Port Hueneme, CA). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

A feasibility study on the design, fabrication and installation of large-diameter, submerged concrete structures for Ocean Thermal Energy Conversion (OTEC) power plants will be conducted. The state-of-the-art related to these structures will be summarized, feasible approaches for fabricating and installing the structures recommended, problem areas enumerated, and research and development areas outlined. (auth)

4770 (APL/JHU-SR—75-2, pp 99-102) **Reinforced concrete constitutive relations for application to OTEC plant structures.** Chen, W.F. (Lehigh Univ., Bethlehem, PA). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

Feasibility studies of ocean thermal power plants have indicated the necessity for the use of large and small structural components of reinforced concrete. The diameter of the hull, for example, is envisioned to be of the order of 100 feet. Deep under the surface of the sea, hydrostatic pressure will be several atmospheres and the behavior of materials such as concrete under these conditions may be substantially different from that normally experienced in air. Theoretical research at Fritz Engineering Laboratory has already progressed to the stage where the constitutive (stress-strain) relations for concrete can be reasonably well predicted under general loading conditions including hydrostatic pressure. An extension of the research to cover reinforced concrete is sought herein. The constitutive relations will be made available to the structural analyst through a computer code in the form of a subroutine for incorporation in existing finite element analysis programs which can be applied to analyze sub-oceanic structures such as the large shells postulated for adoption in the Ocean Thermal Energy Conversion program as well as the usual land-based or underground structures. (auth)

4771 (APL/JHU-SR—75-2, pp 103-105) **Electrical energy transmission from ocean thermal power plants.** Winer, B.M. (Arthur D. Little, Inc., Cambridge, MA). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

Arthur D. Little, Inc. will perform a study to determine which electrical transmission system will be the most appropriate for transmitting the power generated at an Ocean Thermal Energy Conversion power plant to shore. Having estimated the costs and losses associated with electrical transmission, we will compare these results with the results obtained by groups studying the transmission of chemical energy in order to provide an overall picture of the cost trade-off involved. (auth)

4772 (APL/JHU-SR—75-2, pp 106-115) **Tropical ocean thermal power plants producing ammonia or other products.** Dugger, G.L.; Olsen, H.L.; Shippen, W.B.; Francis, E.J.; Avery, W.H. (Johns Hopkins Univ., Laurel, MD). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

A conceptual design and performance estimates for Ocean Thermal Energy Conversion power plants floating in the tropical oceans are presented. Near the equator (+-10° latitude) a temperature difference of 39°F or more between warm surface water (80°F) and water at 2000-3000 ft depth (41°F) generally is available to operate a closed Rankine cycle system. The platform and the heat exchangers will represent approximately 50-75 percent of the basic OTEC plant cost. To minimize these costs, advantages are seen for a semi-submersible platform supporting submerged heat exchangers using large-diameter tubes (to minimize the number of joints and hence labor costs) with the sea water on the shell side to minimize pressure loads on the shell. The plant would be designed for the benign environment in tropical regions where winds are below 25 knots and currents are below 1 knot. With ammonia as the working fluid inside the tubes, two-phase-flow heat exchangers using 6-in.-ID x 0.1-in.-wall aluminum tubing would require approximately 10^5 ft^2 of surface area per MW(e) net power output. Plant capital cost is estimated to be $290-360/kW(e) (mid-1974 dollars). Several potential products for shipment to shore, including LH_2, NH_3, and aluminum are discussed; the liquid ammonia, with an estimated cost near $70/ton delivered to shore, may prove most attractive in view of world needs for fertilizers. (auth)

4773 (APL/JHU-SR—75-2, pp 116-120) **Superflywheel for storing energy from OTEC plants.** Rabenhorst, D.W.; Dugger, G.L. (Johns Hopkins Univ., Laurel, MD). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

The writers were asked whether it would be economically feasible to use the power generated at Ocean Thermal Energy Conversion (OTEC) plants to charge "superflywheels" within ships which could carry the stored energy to shore. Our simple calculations indicate an excessive cost for that approach but great promise for use of a superflywheel to handle the diurnal variation in power demand (the "power peaking" problem) for a shore-based power substation which would receive power continuously, at constant level, via undersea cable, from an offshore OTEC plant. The conceptual design of the multi-ring-type, fiberglass superflywheel rotor on which the estimates are based is described briefly. (auth)

4774 (APL/JHU-SR—75-2, pp 121-124) **Optimization study of ocean thermal-energy delivery systems based on chemical-energy carriers.** Gregory, D.P.; Biederman, N.P. (Inst. of Gas Tech., Chicago). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

The purpose of this project is to analyze chemical energy-carrier alternatives for transporting energy from large-scale Ocean Thermal Energy Conversion (OTEC) plants to wholesale energy

markets. More specifically, the objective is to provide a concise technical assessment and economic analysis of components associated with the conversion, storage, transportation, and shore-based receiving facilities for the conversion of OTEC mechanical energy to hydrogen in gas and liquid states and to ammonia. The most energy-efficient and technically feasible systems for synthesizing and transporting these chemicals will be described. A further aspect of this study will be to test the sensitivity of each component, in terms of economics and energy efficiency, to forecasted changes in technology. This should allow statements dealing with the desirability and/or necessity of promoting further work in various areas of energy transmission and conversion related to OTEC plants. (auth)

4775 (APL/JHU-SR—75-2, pp 125-127) **Preliminary research on an ocean energy industrial complex.** Hornburg, C.D.; Lindal, B.; El-Ramly, N. (DSS Engineers, Inc., Ft. Lauderdale, FL). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

This project will address the technical and economic feasibility of developing an Ocean Energy Industrial Complex (OEIC) producing prime products in conjunction with a floating Ocean Thermal Energy Conversion (OTEC) plant to make maximum use of the ocean resources (energy and raw materials) at the site. In addition to providing technical and economic information on the extraction of the major marketable chemicals and minerals from seawater and the production of energy-intensive products, the study will address the limitations of integrated OEIC's, environmental factors related to such complexes, and potential energy savings. Emphasis will be on identifying the processes which require large quantities of electrical and/or mechanical energy and products that can be economically produced by them synergistically at an OTEC plant site. Preliminary process designs will be prepared and capital and operating costs estimated for the most promising group of products. (auth)

4776 (APL/JHU-SR—75-2, pp 128-130) **Economic contribution of 'Artificial Upwelling' mariculture to sea-thermal power generation.** Roels, O.A. (City Coll., New York). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

Deep-seawater has two valuable properties: it is uniformly cold and, compared to surface water, it is rich in nutrients such as nitrate and phosphate which are necessary for plant growth. In tropical and subtropical areas, the temperature difference between the warm surface water and the cold deep water can be used for sea-thermal power generation or other cooling applications such as air-conditioning, ice-making, desalination, and cooling of refineries, power plants, etc. Once the deep water is brought to the surface, utilization of both the cold temperature and the nutrient content is likely to be more advantageous than the use of only one of them. Claude demonstrated the technical feasibility of sea-thermal power generation in Cuba in 1930. We have demonstrated the technical feasibility of artificial upwelling mariculture in our St. Croix installation. Our results to date demonstrate that the gross sales value of the potential mariculture yield from a given volume of deep-seawater is many times that of the sales value of the power which can be generated by the Claude process from the same volume of deep water. Utilizing both the nutrient content and the cold temperature of the deep water may therefore make sea-thermal power generation economically feasible. (auth)

4777 (APL/JHU-SR—75-2, pp 133-137) **Ocean thermal power plant heat exchangers.** Czikk, A.M.; Fenner, G.W.; Notaro, F.; Zawierucha, R.; McLaughlin, D. (Union Carbide Corp., Tonawanda, NY). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

Promising concepts for OTEC plant heat exchangers were identified. Shell and tube exchangers, with the seawater tubeside for close control of water velocities, are preferred. For the evaporator, a state of the art design would use a horizontal flooded bundle, as large as 12 ft diameter. Evaporator cost is discussed. The preferred designs use large sprayed bundles, which can be either horizontal or vertical. Lower costs are expected for the preferred designs, because of wrap-up and installation savings. For the condenser, a large vertical bundle using fluted tubes is preferred. (auth)

4778 (APL/JHU-SR—75-2, pp 138-142) **Plastic heat exchangers for ocean thermal energy conversion.** Suratt, W.B.; Hart, G.K.; Sieder, E.N. (DSS Engineers, Inc., Ft. Lauderdale, FL). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

Conceptual designs of both tubular and flat-plate units of low-cost, plastic heat exchangers for Ocean Thermal Energy Conversion (OTEC) have been made in sufficient detail to estimate costs. Thin plastic walls of high-density polyethylene loaded with thermally conductive graphite filler (20 percent) and coated with multilayered thin films of impermeable plastics are assumed. Thermal and hydraulic analysis indicates that a flat-plate geometry using ammonia in the falling film mode is the smallest and lowest cost concept evaluated, yielding an average overall heat transfer coefficient of 271 Btu/hr-^{0}F-ft^{2} for the evaporator with a fouling resistance of 0.0005. The estimated total cost for the evaporators and condensers for a 240-MW(e) (gross) OTEC plant is $11,200,000, which includes total replacement of plastic components twice during a 36-year plant life. This cost amounts to $47/kW(e) gross (or $70/kW(e) net for 160-MW(e) net power output) for the OTEC plant designed by Lockheed and Bechtel, which is an order of magnitude lower than their cost estimates for metallic heat exchangers. The largest cost component is steel support structures and piping at 56 percent for a flat-plate unit and 66 percent for a tubular unit. Prospects for successful development appear to be good. Technical uncertainties needing verification include working-fluid film coefficient and pressure drops, and thermal conductivity, long-term creep, and environmental-stress-cracking resistance of graphite-filled-plastic composites. (auth)

4779 (APL/JHU-SR—75-2, pp 143-144) **Nucleating vaporization and extended surface heat transfer at low temperature difference.** Sabin, C.M.; Poppendick, H.F.; Sellers, A.J. (Geoscience Ltd., Solana Beach, CA). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

A program is being undertaken to investigate means for decreasing the size and pumping power requirements of OTEC power plant heat exchangers. The program consists of two parts. One part is directed toward enhancement of nucleate boiling of ammonia over tubes, and the other part is directed toward the enhancement of water side heat transfer without a prohibitive increase in pumping power. (auth)

4780 (APL/JHU-SR—75-2, pp 145-146) **Concurrent studies of enhanced heat transfer and materials for ocean thermal exchangers.** Rothfus, R.R. (Carnegie-Mellon Univ., Pittsburgh). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

Carnegie-Mellon University and the Aluminum Company of America will conduct concurrent studies over the next twelve months seeking to lower the cost of ocean thermal heat exchangers. Enhancement of heat transfer on both the power fluid and seawater sides by means of fine, axial flutes will be investigated experimentally. The behavior of aluminum alloys in the presence of seawater and working fluids such as ammonia will be studied to establish the impact of these materials on the cost-effectiveness of the proposed design. (auth)

4781 (APL/JHU-SR—75-2, pp 147-150) **Potential advantages of mixtures as working fluids in the OTEC cycles.** Iqbal, K.Z.; Starling, K.E. (Univ. of Oklahoma, Norman). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

Mixtures are shown to offer potential advantages over pure compounds as working fluids in ocean thermal energy conversion cycles. Power plant capital costs per unit of energy output potentially can be reduced using mixtures because of increased thermal efficiency and/or decreased heat exchanger size requirements. (auth)

4782 (APL/JHU-SR—75-2, pp 151-154) **Prevention of biofouling of heat transfer surfaces of ocean thermal energy converters.** Jones, P.E.; Ostrozynski, R.L. (Allied Chemical Corp., Buffalo). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

The build-up of marine organisms on the heat transfer surfaces of the evaporator and condenser components of an Ocean Thermal Energy Conversion (OTEC) power plant will significantly reduce the plant's efficiency. Allied will study the prevention of this growth by treatment of the surfaces with a monomolecular, hydrophobic, toxic layer. Long-chain fluorochemicals and tin-based toxicants will be attached to the metal surfaces by means of a chromate conversion coating. Similar treatments have been developed for desalination plants and were shown to be highly effective in producing dropwise condensation and low surface energy. Test samples will be evaluated in simulated and actual marine environments. (auth)

4783 (APL/JHU-SR—75-2, pp 155-156) **Study of fouling and corrosion problems in a solar sea power plant.** Fetkovich, J.G. (Carnegie-Mellon Univ., Pittsburgh); Bernstein, I.M.; Grannemann, G.; Munchmeyer, F.C. Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

Plans for a study of ocean-side fouling and corrosion in the heat exchanger tubes of a solar sea power plant are discussed. A bundle of seven "heat exchanger" tubes 1 inch diameter and 10 feet long will be submerged off the coast of Oahu. Several combinations of tubing material and biofouling inhibitor will be tested for resistance to fouling and corrosion under varying conditions of flow. (auth)

4784 (APL/JHU-SR—75-2, pp 157-161) **Control of microbial slime films in OTEC heat exchangers.** Dexter, S.C. (Woods Hole Oceanographic Institution, MA). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

The conditions in terms of time and depth of exposure under which biofouling occurs have been measured for a typical subtropical open ocean site. Some results of recent research on a new method of slime film control involving manipulation of the substrate wettability rather than the use of leachable toxicants are presented, and these results are discussed in the context of controlling biofouling on the seawater side of OTEC heat exchanger tubing. (auth)

4785 (APL/JHU-SR—75-2, pp 162-171) **Oceanographic and socio-economic aspects of an ocean thermal energy conversion pilot plant in subtropical Hawaiian waters.** Bathen, K.H. (Univ. of Hawaii, Honolulu). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

This study of the nearshore application of an Ocean Thermal Energy Conversion (OTEC) pilot plant in subtropical Hawaiian waters began with a review of several potential OTEC sites. Keahole Point on the Kona (west) coast of Hawaii was selected as the "optimum" site, and the remaining oceanographic and legal/socio-economic studies were keyed to the local oceanographic environment and the impacts of a 20-MW(e) pilot plant upon that environment. Estimates were made of the pilot plant's cold-water discharge plume behavior and geometry, local surface heat exchange and potential alteration due to the cold water discharge, transport of water from the plume impact area by horizontal advection and mixing, nutrient transfer to the surface mixed layer, biostimulation in the mixed layer, and local oceanographic extreme conditions for which the plant would be designed. Results indicate that nutrient levels in surface waters would increase by up to 300 percent within a 260-m radius from the cold-water discharge point, resulting in up to a 1500 percent increase in phytoplankton and a 540 percent increase in herbivores. The legal aspects of a nearshore OTEC plant studied relate primarily to state laws and water quality standards. Potential federal requirements also are reviewed and summarized. Socio-economic conditions in the Keahole area have been characterized, and an input-output analysis of the impact of a new energy source on the economy of Hawaii has been modeled. Because the electricity rates in Hawaii are among the highest in the nation, and the North Kona coast economy is growing rapidly, a cost-competitive 20-35-MW(e) OTEC plant should be successful and stimulating to the Hawaiian economy. This opinion remains provisional, however, until the price of electricity from an OTEC plant can be specified. (auth)

4786 (APL/JHU-SR—75-2, pp 172-173) **Ocean thermal energy conversion: a case study of resource assessment and environmental impact using a proposed Puerto Rico site.** Atwood, D.K. (Univ. of Puerto Rico, Mayaguez). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

Near tropical islands, there exist thick, warm ocean surface mixed layers, which are quite stable in temperature. Below these layers, a rapid and stable thermocline results in a relatively shallow source of cold water. These conditions, combined with the proximity of a market for power, make ocean waters near these islands excellent areas for siting ocean thermal energy conversion (OTEC) plants. The University of Puerto Rico Marine Sciences Department is presently beginning a case study of one such site near Puerto Rico, with a view toward assessing the resource potential of such areas and predicting the environmental impact of placing OTEC plants within them. (auth)

4787 (APL/JHU-SR—75-2, pp 176-178) **Thermocline perturbations and available temperature contrast for ocean thermal power plants.** Piacsek, S.A. (Naval Research Lab., Washington, DC); Toomre, J.; Warn-Varnas, A.; Roberts, G. Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

This study is concerned with the resource availability and environmental impact of ocean thermal power plants (OTPP's). It will rely on modelling techniques and numerical simulations available from geophysical fluid dynamics, including oceanography, meteorology, and turbulent, stratified flows. The work will be pursued concurrently in four task areas: (1) computation of the flow directly forced by the engine pumps; (2) computation of the long-range dispersion of ocean perturbations and estimate of thermocline recovery times; (3) computation of large-scale dispersion in an ocean basin and possible dynamic impact on the water circulation; and (4) estimation of possible sea surface effects and any consequent weather modification. Preliminary estimates from a two-dimensional turbulent calculation in Task 1, for a simplified TRW design with cold water discharge above the center of the thermocline (i.e., into a weakly stratified region), indicate a 30 percent drop in the temperature contrast across the engine in the absence of ocean currents or engine propulsion. (auth)

4788 (APL/JHU-SR—75-2, pp 179-181) **Legal considerations of OTEC: some initial views.** Knight, H.G.; Nyhart, J.D.; Stein, R.E. (American Society of International Law, Washington, DC). Aug 1975.

From Workshop on ocean thermal energy conversion; Houston, Texas, USA (8 May 1975).

In Proceedings, third workshop on ocean thermal energy conversion (OTEC).

The development of technology for ocean thermal energy conversion, coming at a time when the law governing ocean use is in flux, poses a need for legal policy research. This project will identify subjects of needed inquiry within at least these broad areas: rights to emplace and maintain installations; rights to utilize the water of the oceans and potentially change its temperature; sources and content of legal standards governing emplacement and operation; questions of responsibility and liability; and the juridical status of operators and installations. The project will examine each of these areas in light of several key variable factors, including law of the sea implications, the environmental consequences, domestic and international regulation, and international political implications. An interdisciplinary panel will pursue these inquiries in the context of evolving technology for ocean thermal energy conversion. Its work in progress and findings will be communicated to other Grantees and, reciprocally, will endeavor to take their findings into account. (auth)

4789 (COO—2691-1) **Design of cold water pipe for sea thermal power plants. Progress report, 1 May 1975—15 September 1975.** Anderson, J.H. (Sea Solar Power, Inc., York, Pa. (USA)). Sep 1975. Contract E(11-1)-2691. 43p. Dep. NTIS $4.00.

This report covers the preliminary analysis of design conditions for a 40 ft. diameter cold water supply pipe for a 100 MW sea solar power plant. The 4000 ft. long pipe is assumed to be freely suspended from a floating platform. Internal pressure conditions are calculated for maximum assumed flow rates in the pipe. The design is based on a circular row of tubes with spacers between to form the pipe wall. Collapse stability calculations are made for the pipe and for the individual tubes. Drag and moment distributions are calculated for the pipe, and stress calculations made for these preliminary design conditions. It is concluded that the basic design is feasible and justifies more precise analyses. (auth)

4790 (NSF/RANN/SE/GI—39114/PR/75/1) **Solar Sea Power Project. Progress report, January 1, 1975—August 31, 1975.** Lavi,

A. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). 31 Aug 1975. 176p. Dep. NTIS $8.50.

The cost estimates based on current state of technology produced by industry evaluators are reconciled with each other and with the estimates of the Carnegie--Mellon University SSPP team. A plan of action is proposed whereby the ocean thermal energy conversion concept can be advanced from the paper studies phase to hardware testing and development. No major unknowns or problems have been uncovered to justify further delay. In fact, the studies and evaluation to date confirm earlier positive predictions. The ocean thermal concept can be a viable source of energy for the U.S. at an acceptable economic, environmental, and social cost. (auth)

4791 (NSF/RANN/SE/GI—39114/TR/75/1) **Effects of fluid flow on heat exchanger concepts.** Rothfus, R.R. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). 5 Sep 1975. 59p. Dep. NTIS $5.50.

This report covers the conceptual design of heat exchangers for OTEC power plants. The work is restricted to shell and tube designs with sea water flowing vertically inside the tubes and the ammonia working fluid on the outside. The unique aspect of these heat exchangers is the large number of tubes required. While the evaporator and condenser are similar in many respects, the evaporator problem is more crucial in terms of pressure and temperature losses and vapor quality. For the evaporator a falling film on fluted surfaces is considered. The question of pressure losses is examined in detail and a manifolding scheme which reduces the pressure losses to acceptable limits is evaluated through realistic examples. Finally, the introduction of liquid film on the evaporator surface is examined and a scheme for the uniform feed of the liquid is proposed. The distributor proposed permits feeding the tubes through an inlet plenum which in addition to uniformly feeding a large number of tubes attenuates the minor pressure perturbations in the system. It is concluded that: (1) the vapor should be collected (or dispersed) at right angles to the tubes; (2) by removing some of the tubes to create channels for vapor flow, the total pressure loss can be reduced to 1 percent of the realizable pressure difference; and (3) a distributor for the evaporator tubes can be implemented which results in the uniform wetting of all tubes in a module. (auth)

4792 (PB—242152) **Design and off-design performance analysis of ocean thermal difference power plant turbines.** Veenema, R.J. Jr.; Ambs, L.L. (Massachusetts Univ., Amherst (USA)). May 1975. 120p. (NSF/RA/N—75-031). NTIS $5.25.

A procedure has been developed to determine the axial-flow turbine design that operates at the maximum attainable efficiency for the design specific speed. The procedure uses the results of Balje's optimization study and accounts for the Reynolds number variation of Balje's optimized parameters. The procedure has been used to study the variation of the design parameters of ammonia and propane OTDM turbines. A procedure has been developed to predict the off-design performance of turbines designed by the previously mentioned design procedure. The inlet state, mass flow and rotational speed have been varied to produce performance maps for a series of ammonia and propane OTDM turbines. (auth)

4793 (PB—242248) **Proposed ocean thermal energy conversion systems program plan (the OTECS plan).** Hernoemus, W.E. (Massachusetts Univ., Amherst (USA)). Mar 1975. 72p. (NSF/RA/N—75-030). NTIS $4.25.

A program plan for development and acquisition of significant ocean thermal energy conversion systems (OTECS) is presented. Existing research results are to be reduced to one or more bidder's packages via a contract definition phase evolution of one year conducted from a new and appropriately staffed program management headquarters. A standardized nomenclature system for description of any OTECS is presented. A technical development plan derived from existing research results is presented in considerable detail. Finally, a program summary is presented. (auth)

4794 (PB—244786) **Analysis of the thermal and nutrient properties of the condenser discharge plume created by an ocean thermal difference power plant.** (Massachusetts Univ., Amherst (USA)). Oct 1974. 60p. (NSF/RA/N—74-185). NTIS $4.25.

The condenser plume created by a submerged ocean thermal gradient electricity generating system is described and analyzed for various outlet geometries from the point of view of maximizing potentially beneficial effects to marine biota stemming from such a discharge. The overall system concept and basic thermodynamics of the ocean thermal difference process are presented. The integral conservation model for the plume behavior is discussed and the range of variables (outlet geometries and ambient conditions) considered. (NTIS)

4795 **GULF STREAM BASED OCEAN THERMAL POWER PLANTS.** McGowan, J.G.; Heronemus, W.E. 75-643. New York; United States of America (USA); American Institute of Aeronautics and Astronautics (1975). 10p.

From Solar energy for earth conference; Los Angeles, California (21 Apr 1975).

The results of an ongoing analytical study for the design of major components and a total system for Gulf Stream based ocean thermal power plants, up to 400 MWe net, are presented. Critical subsystems and components (such as heat exchangers, cold water inlet pipe, and containment hulls) are identified and the technical basis of their design and selection is discussed. Details of the latest total power system configuration (the Mark II design) are given and key problem areas for future implementation of the concept are summarized. (auth)

4796 **Solar sea power plants (SSPP).** Strauss, A.M. (Univ. of Cincinnati). pp 786-795 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The paper relates to the present state-of-the-art and the building of demonstration plants and not to the eventual massive build up of ocean-based SSPPs. It is crucial that any demonstration projects be very successful if the SSPP concept is to grow and eventually succeed in producing significant amounts of energy, and it is to the demonstration aspects of SSPP design that this paper addresses itself. (auth)

SOLAR RADIATION UTILIZATION

SPACE HEATING AND AIR CONDITIONING

4797 (AD/A—002563) **Solar heating and cooling of buildings study conducted for Department of the Army. Volume II.** (General Electric Co., Philadelphia, Pa. (USA). Space Div.). Jun 1974. 597p. NTIS $13.25.

A study of the use of solar energy for the heating and cooling of buildings at Army installations was conducted with two principal objectives: (1) the preliminary design of a solar heating system for retrofitting on an existing building and (2) the evaluation of solar system concepts for the combined heating and cooling of a building in the construction planning phase. A two story administration building at Fort Belvoir, Virginia was selected for the retrofit heating only application and a single story classroom building planned for Fort Huachuca, Arizona, was selected for the evaluation of combined solar heating and cooling system concepts. In both applications, the solar energy was absorbed by roof mounted, flat-plate collectors, heating a circulating water flow which was collected in large thermal storage tanks until needed. Assessments were made of the principal technologies associated with solar collectors, thermal energy storage, and cooling by means of solar energy. Implementation plans for follow-on phases describing further design activities, schedules, and cost estimates are provided for both the Fort Belvoir and Fort Huachuca Buildings. (GRA)

4798 (COM—75-11070) **Solar heating and cooling in buildings: methods of economic evaluation. Final report.** Ruegg, R.T. (National Bureau of Standards, Washington, D.C. (USA)). Jul 1975. 48p. (NBSIR—75-712). NTIS $3.75.

Economic issues important to the design, and evaluation of solar heating and cooling systems in buildings have been studied. The report explains and illustrates with simple, but realistic examples the use of life-cycle cost analysis and benefit-cost analysis to evaluate and compare the economic efficiency of solar and conventional energy systems. It also explains the conditions for making cost-effective tradeoffs in solar system/building design. By presenting the basic methods and assessing the appropriateness of alternative assumptions, the paper provides a resource document for researchers and analysts. (NTIS)

4799 (COO/SH-C—903/75/1) **Feasibility demonstration of solar-powered turbocompressor air conditioning and heating system.** Biancardi, F.R.; Meader, M.D.; Schulman, E.R. (United Technologies Research Center, East Hartford, Conn. (USA)). Oct 1975. 90p. Dep. NTIS $5.00.

This report describes work performed under Contract NSF-C903 to demonstrate the feasibility of operating a Rankine cycle turbocompressor air conditioning and heating system at temperature levels consistent with present-day, flat-plate solar collectors. Major efforts under this contract have included the analysis, design fabrication, and installation of a demonstration turbocompressor

system at UTRC using selected existing key components modified for this application, conducting selected tests of the demonstration system to obtain supporting design, performance, and operational information over a wide range of conditions, and conducting studies to identify and determine the performance potential for present and future configurations of the turbocompressor system. (auth)

4800 Technical and economic evaluation of solar heating and cooling of building. Turbyfill, R.O.; Cohen, A.D. (General Electric Co., King of Prussia, PA). pp 1-6 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

An analysis is presented of the technical and economic feasibility of using solar energy for heating and cooling of buildings within a time frame of 25 years from now until AD 2000. Performance estimates were generated for 12 climatic regions within the United States on a matrix of eighteen building types. Four types of solar heating and cooling systems were included in the study consisting of: (a) Direct Heat Exchange Solar Heating Systems; (b) Solar Assisted Heat Pumps Systems; (c) Solar Assisted Absorption Air Conditioning; and (d) Solar Rankine Cooling Systems. By hourly computer simulation analysis, information was derived which determined the amount of electric or fossil energy required to supplement solar energy over an entire heating and/or cooling season. Coupling this information with projected utility and fuel costs thru the year AD 2000 and with the capital and operating expenses of the solar equipment, a life cycle economic assessment is made. Finally a market projection is made to portray potential impact of solar energy systems on National Energy Savings by the year 2000 AD. (auth)

4801 (ERDA—75) Catalog on solar energy heating and cooling products. (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Solar Energy). Oct 1975. 445p. Dep. NTIS $12.75.

This catalog is intended to serve as a quick reference to products that are specifically designed for use in conversion or control of solar energy into useful energy for domestic water heating, space heating, space heating and cooling and industrial process heat. This catalog is intended for use by manufacturers of components and subsystems to identify each other for the purpose of offering systems; by architectural and engineering firms to select products; and by users and owners to locate products. The contents of this catalog are restricted to those products that are currently being manufactured or are in advanced stages of development leading to near-term manufacturing within the United States. In June, 1975, a Request for Information (RFI) was issued to manufacturers and developers of solar heating and cooling products. The RFI asked manufacturers to answer a series of questions about each product and to enter the answers on a one-page form. Responses were requested by August 11, 1975. Each listing in this catalog is a photographic reproduction of the forms submitted by the manufacturers. The Table of Contents identifies each of the 14 product categories. Within each category, the products are organized alphabetically by manufacturer or developer name. Two indices have been provided. The first is an alphabetical listing of all manufacturers and developers independent of their product's category. The second index is an alphabetical listing of manufacturers and developers within states. (WDM)

4802 (KAPL-P—4017) Analytical modeling of solar energy systems for heating and cooling buildings. Shen, C.N.; Harris, A.W. (Knolls Atomic Power Lab., Schenectady, N.Y. (USA)). 1975. 34p. (CONF-750817—1). Dep. NTIS $4.75.

From 6. world congress on international federation of automatic control; Boston, Massachusetts, USA (24 Aug 1975).

The development and successful demonstration of an analytical model of a building heating and cooling system having solar energy as its main energy supply is presented. A routine for estimating intra-day solar radiation intensities from calculated clear day values and readily available climatological data is developed. Performance curves for a heat-driven absorption air cooler are presented in terms of characteristic system operating temperatures. The analytical model combines detail in the specification of solar radiation intensities and in the representation of cooling cycle performance with equivalent treatment of the collector and storage sub-systems to result in a model of the overall system that allows the evaluation of the effects of variations in design, operational, and control parameters not possible in earlier related efforts. (auth)

4803 (NSF—74-41) Solar energy utilization for heating and cooling. Yellott, J.I. (comp.). (Arizona State Univ., Tempe (USA)). 1974. 22p. GPO $0.70.

This comprehensive study of currently available design data encompasses qualitative and quantitative aspects of solar energy, technology of solar energy utilization, applications of solar collectors, heat shortage systems, cooling by solar energy, cooling by nocturnal radiation and evaporation, and solar heating and cooling systems. (WDM)

4804 (PB—239355) Conservation and better utilization of electric power by means of thermal energy storage and solar heating. Solar collector performance studies. Lior, N.; Saunders, A.P. (National Center for Energy Management and Power, Philadelphia, Pa. (USA)). Aug 1974. 126p. NTIS $5.75.

Comparative evaluation of 24 types of flat-plate solar collector configurations was performed. In addition to insolation collection tests, separate experiments were conducted to determine heat losses. The experimental facilities utilized are described. The various collector configurations were designed with a view to improving the absorption of solar energy and to reducing the heat losses from the collector window. The collectors, as well as the major materials used in their construction, were experimentally evaluated. (auth)

4805 (PB—239397) Solar energy school heating augmentation experiment: design, construction, and initial operation. Report for 16 January—15 May 1974. (InterTechnology Corp., Warrenton, Va. (USA)). 4 Dec 1974. 84p. (NSF/RA/N—74-019). NTIS $4.75.

This report describes the Fauquier High School proof-of-concept experiment, a solar heating system, designed and built under the joint sponsorship of the National Science Foundation and Intertechnology Corporation. The system consists of a 2540 square foot collector array on a collector building 126 ft by 26 ft, with a net absorber area of 2,415 square feet, two 5,500 gallon concrete insulated storage tanks, a control room/pump house and an automatic control system. The solar heating system was designed to provide 100 percent of the heat required for five, modular-construction classrooms. (auth)

4806 (PB—239516) Solar heating experiment on the Grover Cleveland School, Boston, Massachusetts. Final report on Phase 1, January—May 1974. Notestein, J.E.; Fowler, C.D. (General Electric Co., Philadelphia, Pa. (USA). Space Div.). 15 Jul 1974. Contract NSF-C869. 206p. (NSF/RA/N—74-064). NTIS $7.25.

The site selection, design, construction, and initial operating period of a solar heating system installed on a metropolitan Boston school are described. The solar array is 4600 square feet with a peak energy output in excess of 1 million Btu/hr and heats approximately 21,000 square feet ($^1/_3$) of the school. The system went from the concept stage to first operation in 41 days and was the first large scale heating system operating in this country. Performance data and operating experiences through May 15, 1974 along with overall conclusions are reported. (auth)

4807 (PB—239941) Residential energy consumption and small-scale options of energy systems for space heating. Chan, D.C. (Mitre Corp., Bedford, Mass. (USA)). Nov 1974. 64p. (MTR—2951). NTIS $4.25.

The recent oil crisis has drawn attention to New England's extreme dependence upon oil as a source of energy and, in particular, for space heating. In this study some alternatives to conventional fossil-fueled space heating systems are evaluated in terms of total annual costs to the consumer and fuel demand. It is concluded that a solar collector system back-up by conventionally fueled systems will be economically competitive if mass production is successful in reducing the manufacturing costs of solar panels. (auth)

4808 (PB—240610) Solar heating proof-of-concept experiment for a public school building. Report for January—May 1974. (AAI Corp., Baltimore, Md. (USA)). Jun 1974. 125p. (NSF/RA/N—74-096). NTIS $5.25.

A solar heating proof-of-concept experiment (POCE) for a public school building is discussed. The school received 90 percent of its heat from the solar heating system and it was proven that solar heating of schools is possible, practical, and socially acceptable. In addition, more than 1200 gallons of fuel oil were saved. This report describes the system in detail, presents the analysis of operation, and discusses recommendations and conclusions based upon the results of the experiment. (auth)

4809 (PB—240611) Solar heating and cooling experiment for a school in Atlanta. Design report, June—September 1974. (Westinghouse Electric Corp., Baltimore, Md. (USA)). Dec 1974. 268p. NTIS $8.50.

The first large scale integrated system providing heating and cooling for a building utilizing solar energy has been designed for the George A. Towns Elementary S hool in Atlanta, Georgia. Solar

cooling is provided through the use of a hot water fired lithium bromide absorption chiller to satisfy building cooling loads. Hot water for heating and cooling is provided by a 10,000 sq. ft. solar collector array using reflective surfaces to obtain some concentration during summer months. Approximately 60 percent of the heating and cooling loads are expected to be met by solar energy, the balance by natural gas. The report contains details of design and principles of operation. (GRA)

4810 (PB—241117) **Solar heating/cooling of buildings: current building community projects.** (National Research Council, Washington, D.C. (USA)). 1974. Contract NSF-C310. 47p. NTIS $3.75.

Brief descriptions of 21 projects involving the use of solar energy for heating and cooling buildings are presented. (auth)

4811 (PB—243455) **Assessment of solar-powered cooling of buildings. Final report.** Curran, H.M. (Hittman Associates, Inc., Columbia, Md. (USA)). Apr 1975. 180p. NTIS $7.60.

An assessment of solar-powered cooling of buildings using Rankine cycle engines or absorption cycle equipment is presented. In this type of application thermal energy obtained from the sun would be used to drive a Rankine engine or an absorption cooling unit. The report covers technical and economic feasibility of the concepts. (NTIS)

4812 (PB—243498) **Research evaluation of a system of natural air conditioning. Final report.** Haggard, K.L.; Edmiston, J.W.; Feldman, J.; Hawes, M.; Niles, P.W.B. (California Polytechnic State Univ., San Luis Obispo (USA)). Jan 1975. Contract HUD-H-2026R. 364p. NTIS $10.00.

A system of natural air conditioning which uses roof-ponds and movable insulation to heat and cool buildings is described. The system is evaluated in terms of 9 aspects: architecture, methodology, construction, movable insulation system, collector-dissipator-storage system, automation, thermal design and performance, occupancy behavior, and economics. (NTIS)

4813 (PB—244174) **Modifications to the Lockheed-Huntsville solar heating and cooling systems simulation program. Final report, 7 June 1974—7 June 1975.** McCormick, P.O. (Lockheed Missiles and Space Co., Huntsville, Ala. (USA)). 7 Jul 1975. (LMSC-HREC-TR-D—390846; NSF/RA/N—75/059). NTIS $3.75.

This study was undertaken to make the Lockheed—Huntsville solar heating and cooling systems simulation program more adaptable to general use. During this study the program was made more flexible for the user by input/output modifications and model improvement. A sample parametric study is provided to demonstrate the typical utilization of the program. A section is included which describes the limitations of the model as well as a section on actual use of the program (input/output). (NTIS)

4814 (PB—244872) **Research on solar energy storage subsystems utilizing the latent heat of phase change of paraffin hydrocarbons for the heating and cooling of building. Semiannual report.** Bailey, J.A.; Mulligan, J.C.; Liao, C.K.; Guceri, S.I. (North Carolina State Univ., Raleigh (USA). Dept. of Mechanical and Aerospace Engineering). 1975. 75p. (NSF/RA/N—75-075). NTIS $4.25.

An analytical and experimental research program designed to assess the potential of a solar energy storage subsystem (thermal capacitor) using the latent heat of fusion of paraffin hydrocarbons for the heating and cooling of buildings is described. An idealized model of a flat plate thermal capacitor based on uniaxial heat conduction with a change of phase and an absence of natural convection in the phase change material is assumed. An analysis of the model using the asymptotic expansion and Goodman techniques for the melting (freezing) process is conducted. The analyses are used to generate data concerning the variation with time of the capacitor fluid outlet temperature and internal temperature distribution for various capacitor inlet temperatures, mass flow rates, latent heats of fusion, effective thermal conductivities, and capacitor sizes. An experimental system consisting of a prototype thermal capacitor, fluid flow control unit and hydraulic system for the generation of performance data is described. (NTIS)

4815 (PB—245008) **Solar heating proof-of-concept experiment for a public school building. Final report.** (Honeywell, Inc., Minneapolis, Minn. (USA). Systems and Research Center). 6 Nov 1974. 89p. (NSF/RA/N—74-119). NTIS $4.75.

A 5000-square-foot solar energy system to supplement the heating and hot water requirements of North View Junior High School in suburban Minneapolis is discussed. The report discusses in detail the collector design, system design, system operation, and system performance. (NTIS)

4816 (PB—245669) **Impact of energy developments on the sheet metal industry.** Cohen, A.; Harlow, M.; Johnson, A.; Spewak, P. (MITRE Corp., McLean, Va. (USA)). Jun 1975. 116p. NTIS $5.25.

This report surveys the present energy situation, the federal government's energy policies and programs, and the state-of-the-art in solar heating and cooling of buildings and in energy conservation. It recommends a program of specific action for the Sheet Metal Workers International Association which will, at the same time, serve the Nation's energy needs and provide employment opportunities for the Union's members. (NTIS)

4817 (SAND—75-0542) **Application of solar total energy to a mixed-load community.** Harrigan, R.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1975. Contract AT(29-1)-789. 70p. Dep. NTIS $5.50.

This report investigates the application of solar total energy to a 2000 dwelling unit mixed-load community. The community contains four density zones of residential dwellings as well as three schools and a commercial complex. The community design is consistent with current community planning practices. An energy analysis of the community is performed together with an economic evaluation of a solar total energy system sized to meet the community demands. The effect of dwelling unit density is examined. (auth)

4818 SOLAR COLLECTOR PERFORMANCE EVALUATED OUTDOORS AT NASA-LEWIS RESEARCH CENTER. Vernon, R.W. Washington, DC; United States of America (USA); National Science Foundation (1974). 6p.

From Workshop on solar collectors for heating and cooling of buildings; New York, NY (21 Nov 1974).

The study of solar reflector performance reported is related to a project in which solar collectors are to be provided for the solar heating and cooling system of an office building at NASA's Langley Research Center. The solar collector makes use of a liquid consisting of 50 percent ethylene glycol and 50 percent water. A conventional air-liquid heat exchanger is employed. Collector performance and solar insolation data are recorded along with air temperature, wind speed and direction, and relative humidity. (IAA)

4819 CCMS solar energy pilot study. Morse, F.H. (Univ. of Maryland, College Park); Fields, R. pp 6-7 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4820 Summary analysis, NSF-RANN Phase 0 solar heating and cooling of buildings. Wood, B.D.; Yellott, J.I. (Arizona State Univ., Tempe). pp 20-21 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4821 Comparison of market capture potential of single vs multiple structure solar energy space conditioning: 1975-2020. Petersen, H.C. (Utah State Univ., Logan). pp 33-34 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4822 Solar energy in providing for alternate lifestyles. Martin, J.H. (Argonne National Lab., IL). pp 89-90 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4823 Practical aspects of solar heating: a review of materials use in solar heating applications. Grimmer, D.P.; Moore, S.W. (Los Alamos Scientific Lab., NM). pp 23-34 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—(Suppl.).

A review of materials use in solar heating of buildings is presented with the emphasis on outlining important criteria for selecting materials for a particular application. The most important criteria to consider in solar-heating materials applications are durability and cost-effectiveness. In the area of active solar heating systems, materials use in flat-plate collectors is discussed for the various collector components. In addition, materials use is presented for the area of passive solar systems (sun-tempered buildings). (auth)

4824 Operational experience solar heating a Boston school. Notestein, J.E. (General Electric Co., King of Prussia, PA). pp 14-18 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Operational experiences with one of the first large scale, fully automated, solar space heating systems are described. The system is installed on the Grover Cleveland Middle School in Dorchester, Massachusetts, an urban community to the south of Boston. The system first delivered heat on March 6, 1974, and has been in continuous operation since. The surveillance procedures, modifications and maintenance activities which were found desirable in the course of operating the system are described. In addition, some of the relevant experiences are also presented, e.g., an insufficiency of heat, first noticed during the mornings in early December, was traced back to a wiring error (made in June by the conventional heating serviceman), which locked out "conventional" heat and forced the solar system to carry the total heating load until the condition was rectified in mid-December. The use of solar heating in a Boston type area is shown to be feasible, and a summary of the major conclusions is given. (auth)

4825 Integrated solar heated cooled mobile home. Macklis, S.L.; Haas, S.A. (General Electric Co., Valley Forge, PA). pp 38-42 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The primary goal of the program was to use solar energy data and technology base available from existing solar installations to demonstrate the feasibility of mobile home heating and cooling using solar energy. The demonstration was accomplished through the design and construction of a solar mobile home by GE-AEP and Skyline Corp., a major mobile home manufacturer. (WDM)

4826 Solar heat pump comfort heating systems. Cassel, T.A.V. (Bechtel Corp., San Francisco); Lorsch, H.G.; Lior, N. pp 162-170 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

This paper is addressed to the development of an advanced and energy-efficient heating system which integrates solar energy collectors, a thermal energy storage device, a vapor compression heat pump, an auxiliary heat source, controls, and a residence. Using simulation programs written in interactive APL computer language, two proposed solar heat pump systems were modelled for a 1500 square foot Philadelphia, Pennsylvania residence, and were compared to models of direct solar and conventional heating systems over an entire heating season. Comparisons were made on three criteria: resource energy utilization efficiency, effect on electric utilities, and consumer investment incentives. (auth)

4827 Optimum properties of working fluids for solar powered heat pumps. Stiel, L.I.; Allen, R.A.; Murphy, K.P. (Allied Chemical Corp., Buffalo). pp 171-177 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

In this study, the effect of the thermodynamic properties of the working fluid on the performance of a solar powered heat pump has been analyzed. The system consists of a vapor compression cooling or heating cycle combined with a Rankine power cycle. Values of the input fluid properties which result in optimum efficiencies have been determined for upper temperatures of 180° and 300°F. Cycle and overall efficiencies have also been calculated for approximately 20 halocarbons and other substances. The fluids are classified by boiling points, and the results are tabulated for operation both in cooling and heating modes. Plots are also presented indicating the variation of the efficiencies with cycle parameters. (auth)

4828 Design and operation of a solar-powered turbocompressor air-conditioning and heating system. Biancardi, F.R.; Meader, M.D.; Blecher, W.A.; Hall, J.B. (United Technologies Research Center, East Hartford, CT). pp 186-194 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

A demonstration Rankine cycle turbocompressor air-conditioning and heating system capable of operating at temperature levels of 160 to 210°F, consistent with present-day, flat-plate solar collectors, has been designed, fabricated, and tested. The system utilizes a Rankine-cycle power conversion loop. Energy collected by the solar panel is used to vaporize the working fluid in the vapor generator of the power conversion loop. A common, nontoxic refrigerant, R-11, is used as the working fluid for both loops. The design specifications, performance estimates and system considerations of the demonstration system are described. Successful operation of the system over a range of turbine inlet temperatures between approximately 165 and 215°F and condenser temperatures of 90 to 125°F was attained and is discussed. A comparison of the test data and performance estimates for the demonstration system is presented and shows good agreement. More than 4.0 tons of cooling have been produced, and a COP approaching 0.45 has been demonstrated. The performance potential of the turbocompressor system with advanced technology components and at elevated peak temperatures is determined and indicates such a concept provides a competitive means of generating safe, efficient building heating and cooling from solar energy. (auth)

4829 Evaluation of solar-assisted Rankine cycle concept for the cooling of buildings. (Thermokinetics Systems Dept., Columbia, MO). pp 1391-1398 of In Tenth intersociety energy conversion engineering conference. Curran, H.M.; Miller, M. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

In the solar-assisted Rankine cooling concept solar energy is used to evaporate the working fluid at a temperature consistent with the capability of the solar collector, and a regenerative heat exchanger and a fossil-fueled superheater are used to superheat the fluid to obtain a high expander inlet temperature. The vapor exhausted by the expander is cooled to the condensing temperature by passing through the regenerative heat exchanger where it gives up heat to the vapor produced by the solar energy input. This cycle arrangement results in a much higher cycle efficiency than is attainable with low temperature solar energy alone, and thereby reduces the collector size and the capital equipment cost required to satisfy a given cooling load with a load compression refrigeration machine driven by a Rankine engine. (WDM)

DRYING AND CURING

4830 (PB—238073) Research on the application of solar energy to the food drying industry. Progress report No. 3, 1 July—30 September 1974. Lukes, T. (California Polytechnic State Univ., San Luis Obispo (USA)). Oct 1974. 312p. NTIS $9.25.

Feasibility of substituting solar energy for natural gas in the food dehydration industry is discussed. The drying of vegetables at lower than normal temperatures is investigated. Design of solar collector is described. The following tasks are covered: literature review of dehydrated food industry; current and projected energy demands; cost study for dehydration of carrots and prunes and projections for 1975, 1985, 2000; socio-legal implications of solar collectors; and economic and technical feasibility of solar energy to the food drying industry. (NTIS)

WATER HEATING

4831 (PB—238109) Solar energy for process steam generation. Davis, J.P. (Thermo Electron Corp., Waltham, Mass. (USA)). 25 Nov 1974. 40p. (TE—5392-34-75). NTIS $3.75.

The purpose of this study was to assess, in a preliminary way, the performance and economic possibilities of process steam generation by the coupling of low temperature solar collectors (120-240 F) producing low pressure saturated or wet steam to a fuel-driven diesel/compressor which compresses the steam to the desired final conditions (320 F, 60 psig). The system concept is analogous to a heat pump, which extracts low temperature ambient heat, and raises its temperature to a useful level via mechanical

work. The fuel required to power the diesel compressor is approximately 31 percent of the fuel which would have been required to produce the process steam in a direct-fired boiler. An economic evaluation of annual fuel savings, at $1. ($^{50}/_{10}$)^6 Btu fuel cost, to incremental investment required for $2/sq ft solar collectors or $4/sq ft solar collectors yielded 14 percent and 8 percent respectively. (auth)

4832 (UCRL—76390(Rev.1)) **Industrial process heat from solar energy.** Day, J.A.; Clark, A.F.; Dickinson, W.C.; Iantuono, A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 May 1975. 10p. (CONF-750812—13). Dep. NTIS $4.50.

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

Topics discussed include solar pond system design and analysis; pond description and alternatives; pond performance equations; parameter variations; pond performance; material choices; economics; and system variations. (WDM)

4833 **Industrial process heat from solar energy.** Day, J.A.; Clark, A.F.; Dickinson, W.C.; Iantuono, A. (Univ. of California, Livermore). pp 750-758 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

ERDA has a contract with the Sohio Petroleum Company for Lawrence Livermore Laboratory (LLL) to analyze and design a shallow solar-pond water-heating facility that will provide hot water to a uranium leaching operation. The Sohio Project, located about 60 miles west of Albuquerque, New Mexico, mills uranium ore and then leaches with a dilute hot acid solution. This process requires 500 gpm of 140° water per day. The summer power required to heat water supplied from wells at 60°F is 4.8 x 10^6 Btu/d. The solar heater area needed to provide this power during July, assuming 60 percent conversion efficiency, is about 6 acres. Oil-fired water boilers are the conventional source for energy (steam) used to heat water. Solar energy will replace and save about 20,000 barrels of oil each year in addition to saving dollars. (auth)

HEAT ENGINES

4834 (AD/A—012702) **Conference on thermodynamics and national energy problems held at Airlie House, Warrenton, Virginia, June 10—12, 1974. Final report, June 1974—May 1975.** Beckett, C.W.; Brewer, L.; Holler, C.E. Jr.; Hubbard, W.; Rossini, F.D. (National Academy of Sciences - National Research Council, Washington, D.C. (USA)). Jun 1974. 442p. NTIS $11.25.

The conference on thermodynamics and national energy problems was held at Airlie House, Warrenton, VA, 10-12 June 1974, and attended by about 110 scientists and engineers from universities, industry and government. The purpose of the conference was to arrive at both the needs for thermodynamic data in a developed program to achieve national energy self sufficiency, and the capability of thermodynamicists to meet those needs. To achieve this purpose, most of the time of the conference was spent in four parallel panel discussion sessions on coal, fossil fuels other than coal, nuclear energy, geothermal energy, and solar energy and energy storage. The report includes a summary of each panel's recommendations and reasons for them, an overview summary, texts of prepared presentation, and all pertinent discussion. (auth)

SOLAR COLLECTORS AND CONCENTRATORS

4835 (AD/A—004080) **Reflectance and emittance of selected materials and coatings.** Donabedian, M. (Aerospace Corp., El Segundo, Calif. (USA)). 13 Jan 1975. Contract F04701-74-C-0075. 57p. NTIS $4.25.

A literature review was made to provide the reflective and thermal radiative properties (emittance) of a number of selected materials and surface coatings applicable to a few specific satellites. With the data provided, the infrared radiation signature for each surface may be evaluated from both a spectral and directional basis. Properties defined include solar absorptance, normal and hemispherical emittance, spectral reflectance and emittance, and directional (angular) reflectance and emittance. Pertinent data which aid in predicting degradation of the solar absorptance in the space environment are also presented. The selected materials include aluminum alloy 6061, titanium alloy 6A1-4V, beryllium, various titanium dioxide and zinc oxide pigmented (white) coatings, solar cells, optical solar reflectors (second surface mirrors), using both rigid and flexible substrates, black pigmented coatings, and clear and black anodized aluminum coatings. (GRA)

4836 (ANL-SOL—74-01) **Principles of cylindrical concentrators for solar energy.** Winston, R.; Hinterberger, H. (Argonne National Lab., Ill. (USA)). Sep 1974. 18p. Dep. NTIS $4.00.

4837 (CONF-741256—1) **Report on concentrating flat plate compound parabolic collectors.** Rabl, A.; Sevick, V.; Winston, R. (Argonne National Lab., Ill. (USA)). 31 Dec 1974. Contract W-7405-eng-38. 11p. Dep. NTIS $4.50.

From NSF;RANN solar energy workshop; Argonne, Illinois, USA (Dec 1974).

A concentrating solar heater based on the compound parabolic design was constructed and tested at Argonne National Laboratory. A schematic drawing of the 4'x 4' collector is shown. The principal characteristics of the collector are: (a) Concentration factor = 3; (b) Angular acceptance (full angle) = 38°. The large angular acceptance implies that biannual adjustment of the collector orientation is sufficient to accept direct solar radiation. The modest concentration factor of 3 was chosen to permit efficient operation at 130°F above ambient temperature. The experimental results from outdoor tests show good agreement with a detailed theoretical analysis and confirm the expected improvements in performance resulting from concentration. (auth)

4838 (COO—2597-1) **Studies on methods of reducing heat losses from flat plate solar collectors. Annual progress report, August 1, 1974—July 31, 1975.** Hollands, K.G.T. (Waterloo Univ., Ontario (Canada)). Sep 1975. Contract E(11-1)-2597. 63p. Dep. NTIS $5.50.

The objective of this research project is to examine ways of reducing heat losses from flat-plate solar collectors so that they may perform efficiently in solar heating and cooling systems for buildings. This broad objective is being pursued through three specific parallel studies: (1) an experimental and theoretical study on suppression of free convective heat transfer by inclined honeycomb panels; (2) a definitive study of natural convection heat transfer across inclined air layers; and (3) a study of a new innovation in flat-plate solar collectors, the V-corrugated inner cover. The main objective of the honeycomb study is to establish whether in fact effective convection suppression is possible when the honeycomb is in the inclined position. It has been found that in fact it is possible. In particular, a square-celled honeycomb of aspect ratio (cell height to width ratio) of 5 to 1, when inclined at 45° has been demonstrated experimentally to suppress convective heat transfer up to a critical Rayleigh number of 850,000. (Without a honeycomb the critical Rayleigh number is 2,400). Measurements are reported on honeycombs having aspect ratios of 2, 3, 4, and 5. Plots, suitable for design, giving critical Rayleigh number as a function of aspect ratio and angle of inclination are presented. (auth)

4839 (LA—6143-MS) **Integrated solar energy collector final summary report.** Toenjes, R.B. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1975. Contract W-7405-ENG-36. 236p. Dep. NTIS $7.60.

A flat plate solar collector originated by Los Alamos Scientific Laboratories was studied for mass production manufacturing techniques, design improvements, costs, and architectural integration into arrays for residences and light commercial buildings. This collector is a structural unit which doubles as the building roof. It was determined that proper design and materials selection can result in cost-effective collectors which are readily adaptable to building design and meet building code requirements for all but isolated cases. It is recommended that studies of certain components be continued and that additional collectors be fabricated for tests. (auth)

4840 (N—75-12329) **Refinement in black chrome for use as a solar selective coating.** McDonald, G.E. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). Dec 1974. 10p. (NASA-TM-X—3136; E—8116). NTIS $3.25.

Black chrome is significant as a solar selective coating because the current extensive use of black chrome in the electroplating industry as a durable decorative finish makes black chrome widely available on a commercial scale and potentially low in cost as a solar selective coating. Black-chrome deposits were modified by underplating with dull nickel or by being plated on rough surfaces. Both of these procedures increased the visible absorptance. There was no change in the infrared reflectance for the dull-nickel—black-chrome combination from that reported for the bright-nickel—black-chrome combination. However, the bright-nickel—black-chrome coating plated on rough surfaces indicated a slight decrease in infrared reflectance. As integrated over the solar spectrum for air mass 2, the reflectance of the dull-nickel—black-chrome coating was 0.077, of the bright-nickel—black-chrome coating plated on a 0.75-micron (30-microinch) surface was 0.070, of the bright-nickel—black-chrome coating plated on a 2.5 micron

(100-microinch) surface was 0.064. The corresponding values for the brightnickel—black-chrome coating on a 0.0125-micron (0.5-microinch) surface, two samples of black nickel, and two samples of Nextrel black paint were 0.132, 0.123, 0.133, and 0.033, respectively. (auth)

4841 (N—30121) **Spectral reflectance properties of black chrome for use as a solar selective coating.** McDonald, G.E. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1974. 12p. (NASA-TM-X—71596; E—7915). NTIS $3.00.

From US Sect. ann. meeting of the Intern. Solar Energy Soc.; Fort Collins, CO (19 Aug 1974).

The NASA-Lewis Research Center has determined that a widely available, commercially-electroplated, decorative finish known as black chrome has desirable solar selective properties. The spectral reflectance properties of a commercially prepared black chrome on steel were measured. Values are presented for reflectance of the black chrome, and compared with the reflectance of black paint (Nextel) and with two available samples of black nickel which had been prepared for solar selective properties. The reflectance of black chrome, of the two black nickels, and of black paint integrated over the solar spectrum for air mass 2 were 0.132, 0.123, 0.133, and 0.033, respectively. The reflectance of the black chrome, two black nickels, and of the black paint integrated over the blackbody spectrum for 250 F from 3 to 15 microns are 0.912, 0.934, 0.891, and 0.033, respectively. These reflectance measurements indicate absorptivity-to-emissivity values of 9.8, 13.8, 8.0, and 1.00, respectively. (auth)

4842 (PB—236196) **Air-stable selective surfaces for solar energy collectors. Semiannual progress report No. 1, April—30 June 1974.** Meinel, A.B. (Helio Associates, Inc., Tucson, Ariz. (USA)). Jul 1974. 138p. NTIS $5.75.

The purpose and objective of this study is to evaluate the avenues of approach to and behavior of Air Stable Selective Surfaces for Solar Energy Collectors. The primary effort of this program is to evaluate the possibilities for and experimental test of selective surface samples for continued exposure to air and its associated water vapor, carbon dioxide and aerosols to temperature cycles from room temperature up to 150C. A secondary portion of the program is to evaluate collector performance with selective surfaces, in particular, the sensitivity analysis of selective surfaces used on the absorber and on the cover windows. (GRA)

4843 (PB—236208) **Research on cadmium stannate selective optical films for solar energy applications. Semiannual progress report, 1 January—30 June 1974.** Haacke, G. (American Cyanamid Co., Stamford, Conn.). Jul 1974. 31p. NTIS $3.75.

Detailed characterization of sputter coated cadmium stannate films has been carried out. Current deposition technology was found to yield coatings which consist of Cd2SnO4 as major phase and smaller concentrations of CdSnO3 and CdO. The presence of CdO appears to impede the electrical conductivity. Infrared reflectance measurements on cadmium stannate films showed, for some samples, reflectivities as high as 90 percent, these contained impurities. Highest reflectivities were observed in films doped with either tantalum or indium. Indium and tantalum doped films of different thicknesses have been prepared to determine optimum coating thickness required for application in solar thermal collectors. Development of blackwall CdS/Cu2S solar cells on silica/Cd2SnO4 substrates at the Institute of Energy Conversion, University of Delaware has yielded encouraging results. Cadmium stannate resistance can be made small if an appropriate electrical contact geometry is used. (GRA)

4844 (PB—238003) **Summary of results of solar power arrays for the concentration of energy study.** (Sheldahl, Inc., Northfield, Minn. (USA). Advanced Products Div.). 24 Oct 1974. 36p. NTIS $3.75.

Topics cover heliostat array design and performance along with evaluation of reflective membrane materials having potential application in the fabrication of heliostat mirrors. Design and test requirements for a representative section of a solar thermal energy receiver designed for use in a 10 MWe solar thermal energy proof of concept system are discussed. (GRA)

4845 (PB—239758) **Solar collector performance studies.** Lior, N.; Saunders, A.P. (National Center for Energy Management and Power, Philadelphia, Pa. (USA)). 1974. 126p. NTIS $5.75.

Comparative evaluation of 24 types of flat-plate solar collector configurations was performed. A dual-glass flat black collector type served as the test reference, and the other configurations were compared to it. In addition to the insolation collection tests, separate experiments were conducted to determine heat losses. The experimental facilities used are described. (GRA)

4846 (PB—241006) **Chemical vapor deposition research for fabrication of solar energy convertors. Annual progress report, 1 January—31 December 1974.** Seraphin, B.O. (Arizona Univ., Tucson (USA). Optical Sciences Center). 31 Jan 1974. 69p. NTIS $4.25.

This project supports research on a new approach to a selective solar energy convertor that can be used to transform solar radiation into high temperature heat. The selective solar energy convertor is basically a two-layered construction in which the top layer is a semiconductor material, such as silicon, having high absorption for solar radiation and high transparency for blackbody radiation from the heated unit. The bottom layer is a metal film having high reflectance. This report describes the successful transfer of the previously developed technology to stainless steel substrates. Several hundred temperature cycles of the stack up to 500 C did not induce detrimental effects. (GRA)

4847 (PB—241089) **Research applied to solar thermal systems. Semiannual report No. 4, 1 January—31 June 1974.** Sparrow, E.M.; Ramsey, J.W.; Wehner, G.K. (Minnesota Univ., Minneapolis (USA)). Jul 1974. 189p. NTIS $7.00.

Experiments of a scale model trough collector were performed at a desert test site. Absorbed solar energy was measured both for east-west and north-south orientations. The collector was found to absorb up to 61.5 percent of the available solar flux. Continuing life tests of candidate solar concentrator surfaces indicated that certain surfaces showed no degradation in reflectance. Solar absorber coating/substrate structures have been devised for high temperature operation and a technique developed for enhancing coating life expectancy in air. Cost characteristics of three transfer loop systems were determined and the most cost effective one was identified. The cool-down analysis of a fluid-carrying absorber tube during a protracted interval of no insolation indicated that no freezing would occur for a period as long as seven days if the tube were surrounded by a vacuum jacket. Measurements were made of the thermal conductivity of a candidate pipeline insulation. Heat storage techniques involving solid-liquid phase change and single-phase temperature change were investigated. (GRA)

4848 (PB—241090) **Research applied to solar-thermal power systems. Semiannual report No. 5, 1 July—31 December 1974.** Sparrow, E.M.; Ramsey, J.W.; Wehner, G.K. (Minnesota Univ., Minneapolis (USA)). Jan 1975. 112p. NTIS $5.25.

Experiments were conducted on the scale-model parabolic trough collector module at a desert test site. The low-temperature absorber tube used in the prior experiments was replaced by a selectively-coated, heat pipe, absorber tube. Collector performance was measured for absorber tube operation over a range of temperature from 210 to 300C. Auger electron spectroscopy studies of the diffusion phenomena in various solar absorber coatings were continued. An experimental model of a solar boiler/heat exchanger was designed and is being fabricated. The apparatus will serve to simulate a boiler/heat exchanger that would be part of a solar-thermal collector module. Measurements were made of the thermal conductivity of a candidate pipeline insulation. A computer program was writtten and applied for determining the heat transfer characteristics of phase-change heat storage media. Preliminary data runs were made for a single-phase heat storage system. (GRA)

4849 (PB—243908) **Proceedings of the workshop on solar collectors for heating and cooling of buildings, New York City, November 21—23, 1974.** Sargent, S.L. (Maryland Univ., College Park (USA). Dept. of Mechanical Engineering). May 1975. 500p. (NSF/RA/N—75-019). NTIS $12.00.

Summaries are presented of technical presentations and panel discussions that took place at the NSF-Rann solar collector workshop in November 1974. Technical session topics were flat plate liquid heating collectors; flat plate air heating collectors; focusing collectors; collector materials end components; numerical models; and testing and standards. Reports of working groups that met to consider each of these areas are included. (NTIS)

4850 (PB—245019) **Glass solar heat collector development. Six months progress report for period ending April 30, 1975.** Beverly, W.D.; Gillette, R.B. (Boeing Co., Seattle, Wash. (USA)). May 1975. 102p. (NSF/RA/N—75-060). NTIS $5.25.

The objective of this grant was to develop an all-glass-vacuum-insulated solar heat collector for heating and cooling of buildings. The major tasks accomplished during the first six months include: (1) construction and testing of a prototype collector; (2) development of a test facility to accurately measure the performance of the collector designs; (3) completion of the major portion of thermal analyses; (4) investigation into the types of blackening agents available and their behavior under conditions expected in collector operations; (5) development of facilities to test adhesives for the bonded collector design; (6) completion of

preliminary applications studies aimed at incorporating collectors into standard building construction; and (7) discussion with glass manufacturers to obtain technical, manufacturing, and cost information on glass. (NTIS)

4851 (PB—245188) **Evaluation of surface geometry modification to improve the directional selectivity of solar energy collectors. Semiannual progress report, 1 January—30 June 1975.** Howell, J.R.; Bannerot, R.B. (Houston Univ., Tex. (USA). Dept. of Mechanical Engineering). 31 Jul 1975. 44p. (NSF/RA/N—75-081). NTIS $3.75.

Moderately concentrating collectors composed of parallel, east-west oriented, stationary, trapezoidal grooves are examined. Computer simulations of radiative behavior with direct beam, nondirect, and various combinations of insolation are presented. (NTIS)

4852 (UCID—16877) **Semifixed solar-energy concentrator.** Archibald, P.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Aug 1975. Contract W-7405-Eng-48. 24p. Dep. NTIS $4.00.

4853 STATUS OF THE NASA-LEWIS FLAT-PLATE COLLECTOR TESTS WITH A SOLAR SIMULATOR. Simon, F.F. Washington, DC; United States of America (USA); National Science Foundation (1974). 19p.

From Workshop on solar collectors for heating and cooling of buildings; New York, NY (21 Nov 1974).

Simulator test results of 15 collector types are reported. Collectors are given performance ratings according to their use for pool heating, hot water, absorption A/C or heating, and solar Rankine machines. Collectors found to be good performers in the above categories, except for pool heating, were a black nickel coated, 2 glass collector, and a black paint 2 glass collector containing a mylar honeycomb. For pool heating, a black paint, one glass collector was found to be the best performer. Collector performance parameters of 5 collector types were determined to aid in explaining the factors that govern performance. The two factors that had the greatest effect on collector performance were the collector heat loss and the coating absorptivity. (auth)

4854 Solar absorptance and emittance properties of several solar coatings. Pettit, R.B.; Sowell, R.R. (Sandia Labs., Albuquerque, NM). pp 164-165 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4855 Spectral reflectance properties of plated zinc for use as a solar selective service. McDonald, G.E. (Lewis Research Center, Cleveland). pp 166-167 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4856 Comparative measurements of infrared emittance by spectrophotometric and calorimetric methods. McDonald, G.E.; Curtis, H.B. (Lewis Research Center, Cleveland). pp 177-178 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4857 Thermal radiation characteristics of transparent plastic honeycombs for solar collector applications. Marshall, K.N.; Bell, G.A.; Wedel, R.K.; Haslim, L.A. (Lockheed Palo Alto Research Lab., CA). pp 204-205 of In 1975 International Solar Energy Congress and Exposition. Rockville, MD; International Solar Energy Society (1975).

From Annual meeting of the International Solar Energy Society; Los Angeles, California, USA (28 Jul 1975).

See CONF-750712—.

4858 Approaches to fabrication of parabolic trough reflectors. Champion, R.L. (Sandia Labs., Albuquerque, NM). pp 35-45 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—(Suppl.).

The design of parabolic trough reflectors for focusing solar collectors must consider a large number of applicable parameters. Materials, fabrication and installation cost are the most important. Design concepts which offer the potential for low-cost mass production include honeycomb/stressed skin structures, molded plywood, stretch-formed metal skins, and rigid foams. (auth)

4859 Development of a 540 ft² prototype faceted fixed mirror solar concentrator. Williams, J.R. (Georgia Inst. of Tech., Atlanta); Hutchins, S.F. pp 195-201 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

A new type of solar collector has been assembled and tested at Georgia Tech which promises to provide heat at about the same cost as commercially available flat-plate collectors, but at a much higher temperature. The higher temperature permits higher COP air conditioning and heat pump operation, with a resulting decrease in the collector area required and lower air conditioning equipment costs as compared with systems using flat plate collectors. In addition, this focusing collector can supply low-grade steam and other industrial process heat at temperatures to several hundred degrees Centigrade. Using air as the heat-transfer medium, collection temperatures in excess of 400°C have already been achieved using the 540 ft² FFMC. These Data indicate that an average collection efficiency of at least 50 percent at the design temperature of 260°C should be achieved using an improved heat exchanger currently under construction. (auth)

4860 Application of heat pipes to solar collectors. Bienert, W.B.; Trimmer, D.S.; Wolf, D.A. (Dynatherm Corp., Cockeysville, MD). pp 1533-1539 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Several applications of heat pipes to solar collectors have been proposed or are in a state of development. This paper focuses on two current R and D programs which are sponsored by ERDA. In the first program, heat pipes are applied to tracking solar concentrators; while the second one investigates heat pipes for flat plate solar collectors. Since the technologies involved are somewhat different, the presentation is divided into two separate parts. (auth)

4861 Solar-energy materials preparation techniques. Mattox, D.M. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Vac. Sci. Technol.*; 12: No. 5, 1023-1031(Sep 1975).

The application of materials to the thermal control of structures, photothermal/electrical conversion, and photovoltaic conversion are reviewed. Applications include solar and infrared reflectors, optical filters, transparent conductors, bulk semiconductor materials, semiconductor films, and selective solar absorbers. The use of thin films in many conservation and photothermal applications is presently economical, but the economics of photothermal/electrical and photovoltaic conversion is still being investigated. The means of obtaining selective solar absorbers which have a high solar absorptance and low ir emittance are discussed, and specific data on an electrodeposited black-chrome selective absorber is presented. It is shown that solar—electric generating plants must be constructed at a cost of about $50/m² to be competitive with other electrical generating plants, and that a meaningful impact on the electrical energy economy will require a fabrication rate of greater than 1.8 times 10^9 m² (50 square miles) per year. Present high-volume deposition capabilities are reviewed, and it is shown that for some types of deposition, namely electrodeposition, e-beam vacuum evaporation, and possibly sputter deposition, facilities exist which approach the desired volumes.

GEOTHERMAL ENERGY

4862 (ANCR—1139) **FY 1974 program plan for geothermal project.** (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 5 Feb 1974. Contract AT(10-1)-1375. 76p. NTIS $5.45.

The Program Plan specifies the basic plan for the utilization of FY-74 funds allocated by the AEC Division of Applied Technology and contributions from other participants for the development of geothermal energy in southern Idaho. Funding priorities are dictated by the Construction Data Package submission deadline and the October 1, 1974, site selection. Tasks not funded during FY-74 will be pursued during FY-75. (auth)

RESOURCES AND AVAILABILITY

USA

4863 (SAND—75-5492) **Sandia Magma Energy Research Project.** Colp, J.L.; Brandvold, G.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 25p. (CONF-750525—3). Dep. NTIS $4.25.

From 2. United Nations symposium on the development and uses of geothermal resources; San Francisco, California, USA (20 May 1975).

The objective of this project is to perform the basic research and development studies needed to locate and define the potential resources, and to provide the materials technology and engineering concepts required to produce clean, high quality energy from subsurface magma bodies. It will be implemented in four general areas: (1) source location and definition, (2) source tapping, (3) magma/material compatibilities, and (4) energy extraction. The source location studies presently underway supplement and are closely coordinated with the geothermal exploration program of the U. S. Geological Survey. There are many potential sites for a magma demonstration in the western United States. Two will be selected for detailed exploration next year. Source tapping studies will be performed in close cooperation with other ongoing drilling improvement programs. The ability of engineering materials to survive in a magma environment is critical to the success of this project. Material compatibility studies to date show that materials are available that will perform in these conditions. Engineering design studies for utilizing these materials in this environment will be commenced. The magma energy extraction concept being studied at the present time consists of a closed, water/steam, heat exchanger system inserted directly into the molten rock with conventional steam/electric generation equipment. Other concepts for electricity of fuel production will be considered. The environmental impacts (thermal, subsidence, etc.) resulting from energy production will be assessed and monitored. (auth)

4864 (SAND—75-6160) **Can the dream of using magma energy come true.** Colp, J.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 2p. (CONF-751154—1). Dep. NTIS $4.50.

From Center for energy studies; Austin, Texas, USA (24 Nov 1975).

Sandia Laboratories has in progress an engineering research program investigating the feasibility of extracting energy directly from deeply buried circulating magma sources. The study has delineated for major problem areas: a) source location and identification, b) magma properties and material compatibilities; c) source tapping methods; and d) energy extraction equipment. To some degree, work is presently under way in each of these problem areas. (LS)

4865 (UCID—16951) **Geothermal project description: LLL experimental site Salton Sea geothermal field.** Palmer, T.D.; Towse, D.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Nov 1975. Contract W-7405-Eng-48. 17p. Dep. NTIS $4.00.

The Lawrence Livermore Laboratory program for geothermal research requires the development of a field experimental facility in order to conduct a series of tests on turbine prototypes and to analyze the system requirements for power conversion. This report gives a description of the field portion of this experimental program including site development, test activities, and project administration. Additionally, it discusses plans for concurrent field environmental studies and surveillance programs. A series of maps are included to describe land ownership and lease status within the area of interest. Successful completion of the test program will prove the technology necessary for commercial development. An assessment of environmental factors indicates few temporary and no long term adverse environmental effects from this program. (auth)

4866 **Geothermal energy as a resource in a hydrogen energy economy.** Maslan, F.; Gordon, T.J. (Futures Group, Glastonbury, CT). pp 57-85 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Upper limits of the contribution of geothermal energy resources to the production of electric power have been assessed by estimating the technologically feasible levels of installed electric generating capacity utilizing geothermal resources in the years 1985 and 2000. The characteristics of geothermal energy cause it to fit very neatly with the Hydrogen Energy Economy concept. Successful integration may allow economic distribution of geothermal energy in all the various energy forms: electricity, fuel gas, and liquid fuel. (auth)

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOPHYSICAL TECHNIQUES AND SURVEYS

4867 (HIG—75-6) **Geoelectric-geothermal exploration on Hawaii island: preliminary results.** Klein, D.P.; Kauahikaua, J.P. (Hawaii Univ., Honolulu (USA). Hawaii Inst. of Geophysics). Jan 1975. 33p. Dep. NTIS $4.50.

Geoelectric reconnaissance surveys were performed on Hawaii Island to locate areas of low resistivity that might have the potential for commercial geothermal development. The lower northeast end of the Kilauea East Rift Zone has low resistivities (less than 10 ohm-m) that indicate anomalous geothermal conditions. Preliminary results of both AC and DC resistivity surveys indicate that the most promising zone of high temperature waters is at depths of 500 to 1500 meters beneath the 1955 eruptive vents in this region. The temperature in this zone may be as great as 200°C. Further analysis is continuing on the data and additional data are being gathered to attempt to outline the probable extent of the material with low resistivity. (auth)

GEOCHEMICAL TECHNIQUES AND SURVEYS

4868 (LBL—3268) **Non-dispersive soft x-ray fluorescence analyses of rocks and waters.** Herbert, A.J.; Bowman, H.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1975. Contract W-7405-ENG-48. 17p. (CONF-750525—17). Dep. NTIS $4.50.

From 2. United Nations symposium on the development and uses of geothermal resources; San Francisco, California, USA (20 May 1975).

A six anode soft X-ray fluorescence spectrometer is used to analyze the chemistry of rocks and waters. Analyses are checked against neutron activation results for sodium and chlorine on the same samples. Preliminary experiments indicate the possibility of 5 percent or better results when using an appropriate accurately constructed calibration solution. The present sample size for water is 50 ul. The water sample results support the empirical geothermometer of Fournier and Truesdell, and the quartz geothermometer for T greater than 125°C. (auth)

EXPLORATORY DRILLING

4869 (LA—6112-MS) **Geophysical logging in Los Alamos Scientific Laboratory geothermal test hole No. 2.** West, F.G.; Kintzinger, P.R.; Laughlin, A.W. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1975. Contract W-7405-ENG-36. 13p. Dep. NTIS $4.50.

The Los Alamos Scientific Laboratory drilled Geothermal Test Hole No. 2 to a depth of 2932 m (9619 ft) as a part of the "Dry Hot Rock" Geothermal Energy Project. The hole encountered 732 m (2402 ft) of volcanic and sedimentary rocks before penetrating 2200 m (7217 ft) of crystalline rock. Various geophysical logs were run, the most useful for the purposes of the project being the full-wave sonic logs, as an indication of relative competence of the rock, and the spectral gamma-ray log, to indicate general rock type. (auth)

GEOTHERMAL POWER PLANTS

POWER CONVERSION SYSTEMS

4870 (UCID—16954) **LLL Geothermal Energy Development Program status report, January 1975—August 1975.** Austin, A.L.; Howard, J.H.; Lundberg, A.W.; Tardiff, G.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1975. Contract W-7405-Eng-48. 89p. Dep. NTIS $5.00.

The major goal of the LLL Geothermal Program is to develop systems for the recovery and conversion of the energy stored in hot water deposits with particular emphasis on those containing more than 3 percent total dissolved solids. The program consists of three basic activities; brine chemistry and materials technology; energy conversion and systems engineering; and resource assessment. The program activities, findings, and plans are summarized. (LS)

4871 (UCRL—51912) **Geothermal binary fluid cycle: heat exchanger area requirements and initial costs.** Giedt, W.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Sep 1975. Contract W-7405-Eng-48. 27p. Dep. NTIS $4.50.

The basic elements of a geothermal binary-fluid energy-conversion cycle are reviewed and the possible different sequences of states of the secondary or working fluid are discussed. The most

efficient sequence, thermodynamically, is shown to be when this fluid remains in the compressed liquid and supercritical states during heating and expands to a saturated vapor during the work output process. Such a cycle is independent of the particular working fluid used and can be considered an upper bound of the performance that can be achieved with a specified brine inlet temperature. Furthermore, system performance is then only a function of the temperatures of the brine and working fluid leaving the exchanger. Assuming the use of a counterflow heat exchanger, with the working fluid following the supercritical cycle described, determining the optimum operating condition for the system is shown to require combined consideration of the heat-exchanger and energy-conversion-cycle performances. The effect on area and brine flow requirements of operating at off-optimum conditions is discussed. The effects of down-hole pumping power, parallel-counterflow heat exchangers and cost are then included in the analysis. Contours of heat-exchanger area per kilowatt of power generated and of cost per kilowatt as a function of the brine and working fluid exit temperatures are presented. (auth)

4872 **Electric power generation from geothermal hot water deposits.** Austin, A.L.; Lundberg, A.W. (Univ. of California, Livermore). *Mech. Eng.*; **97**: No. 12, 18-25(Dec 1975).

Water-dominated geothermal systems are an energy resource from which a great quantity of clean, low-cost electric energy can be extracted. Three conversion concepts—the flashed steam system, the binary cycle system, and the total flow system—are analyzed for typical wellhead characteristics found in hot-water geothermal resources. Of the three, the total flow concept is the most promising with a potential for 60 percent greater efficiency than either of the other systems. (auth)

GEOTHERMAL ENGINEERING

4873 **Geothermal energy turbine and well system.** Lobach, J.L. (to Sperry Rand Corp.). US Patent 3,908,380. 30 Sep 1975. Filed date 15 Jul 1974. 20p.

A geothermal energy transfer and utilization system makes use of thermal energy stored in hot solute-bearing well water to generate super-heated steam from an injected flow of clean water; the super-heated steam is then used for operating a novel turbine for driving a hot water pump at the well bottom for pumping the hot solute-bearing water at high pressure and in liquid state to the earth's surface, where transfer of its heat content to a closed-loop boiler-turbine-alternator combination is effected for the generation of electrical or other power. Clean water is regenerated by surface-located equipment for re-injection into the deep well and the residual concentrated solute-bearing water is pumped back into the earth. The novel pump driving turbine features a compact and efficient steam turbine configuration adapted for use in the hostile environment of the deep hot-water well. Super-heated steam passes downwardly to impact turbine blades at the periphery of the turbine wheel. A further feature permits the expanding steam then to reverse its sense of flow in a compact arrangement returning the steam along the axis of the turbine wheel and then to the earth's surface for further energy recovery. (auth)

DRILLING TECHNIQUES AND WELL HARDWARE

4874 (ANCR—1247) **Geothermal R and D project report for period April 1, 1975—June 30, 1975.** Kunze, J.F. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Sep 1975. Contract E(10-1)-1375. 69p. Dep. NTIS $5.45.

The Idaho National Engineering Laboratory (INEL) Geothermal Research and Development Project was initially chartered by the Division of Applied Technology in December 1973. This report covers the period April 1, 1975, through June 30, 1975. A brief summary of the work, particularly of the Raft River Geothermal Exploratory Well No. 2 is given in the first section. Subsequent sections give details of the demonstration medium temperature geothermal power plant program, advanced hear exchanger development, non-electric uses of geothermal energy, and the Boise demonstration geothermal space heating project. Plans for the subsequent quarter are outlined. (auth)

4875 (ANCR—1261) **Drilling plan Boise slim (2-3/8 in. diameter) holes Demonstration Space Heating Project, October 1975.** Stoker, R.C. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Oct 1975. Contract E(10-1)-1375. 20p. Dep. NTIS $4.00.

This drilling plan covers the drilling of 2 or 3 slim ($2^{7}/_{8}$ inch diameter) cored exploratory holes and was prepared by the Boise Geothermal R and D Project of the Idaho National Engineering Laboratory. The document provides a basic plan for the development of the exploration drilling phase of the Boise Demonstration Space Heating Project. The drilling plan outlines the areas of responsibility during the hole drilling and a schedule of activities to accomplish the primary objective—confirmation of the geothermal resource model through exploration hole drilling. Further effort is planned to accomplish the following: (1) demonstration of the resource through the drilling of a larger well and (2) recommendations for production well sites for drilling by the State of Idaho through knowledge gained from the exploration holes and demonstration well. (auth)

CORROSION AND SCALING

4876 (UCID—15644-75-2, pp 17) **Development of analytical methods for the energy program. Determination of sulfide in geothermal samples.** Selig, W.; Hill, J.H. 3 Sep 1975.

In General Chemistry Division quarterly report, April—June 1975.

Progress is reported on the following: determination of sulfide in geothermal samples; characterization of geothermal brines; increasing the nucleation barrier for scale formation in geothermal systems; increasing the efficiency of energy transfer and mass transport of liquid-application to geothermal power systems; chemical kinetics studies of geothermal brine; and LLL uranium hydrochemical survey project. (LBS)

WELL PERFORMANCE

4877 **Geothermal reservoir engineering.** Takahashi, P.K. (Univ. of Hawaii, Honolulu); Chen, B. *Geotherm. Energy Mag.*; 3: No. 10, 7-23(Oct 1975).

A summary is given of the state-of-the-art of geothermal reservoir engineering, well testing and analysis, computer modelling, and physical modelling. The reservoir related proceedings of the Second U.N. Symposium on Geothermal Resources are also summarized. (LBS)

ARTIFICIAL STIMULATION

4878 (LA—6115-MS) **Critical borehole pressure for a vertical hydraulic crack in the presence of two principal total stresses.** Hsu, Y.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. Contract W-7405-ENG-36. 5p. Dep. NTIS $4.00.

In hydraulic fracturing in deep boreholes, a vertical hydraulic crack is produced by the processes of breakdown, crack propagation, shut-in, and venting (deflation). It is desired to determine whether, during repumping, the rock will sustain a given borehole pressure in the presence of two horizontal principal total stresses and a preexisting vertical crack extending diametrically outward from a cylindrical borehole. This can be predicted by using the stress-intensity-factor fracture-mechanics approach.

4879 (UCRL—51944) **Effect of electrical potential on scale formation in Salton Sea brine.** Schock, R.N.; Duba, A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Nov 1975. Contract W-7405-Eng-48. 19p. Dep. NTIS $4.00.

Field experiments were carried out at a flowing well in the Salton Sea Geothermal Field to study the influence of electrical potential on scale deposition. The scale is composed mainly of silicon, iron, copper, silver, and aluminum. Significantly more scale formed on negative than on either positive or neutral electrodes. The scale on the cathode contained up to 1000 times more lead than the scale on the other electrodes. It may also contain slightly increased amounts of copper. Although the amount of scale on positive and neutral electrodes appeared to be the same, the scale on the positive electrodes was richer in iron and zinc. X-ray powder diffraction reveals the presence of lead as Pb(OH)Cl and of iron as FeOOH. No crystalline silicon forms were detected. Collectively, the results suggest that both iron and lead are present in complex ionic forms in solution. (auth)

ENERGY UTILIZATION

CONSUMPTION RATES

4880 (ANCR—1246) **Feasibility conceptual design study for Boise Geothermal Space Heating Demonstration Project building modifications.** Donovan, L.E.; Richardson, A.S. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Sep 1975. Contract E(10-1)-1375. vp. Dep. NTIS $5.45.

Based on the premise that a geothermal fluid source of quality and having thermal properties similar to the existing Old State Penitentiary well water can be confirmed in the same general location, a feasibility/conceptual design effort for the Boise Space Heating Demonstration Project was started to determine practical ways to use this energy. The design activity included studies to establish methods by which certain public, State of Idaho buildings

in Boise could economically be converted to utilize geothermal energy for space heat in lieu of presently installed more conventional heating systems. The first portion of that conceptual design effort is the required building modifications and is the basis for this report. (auth)

GEOTHERMAL DATA AND THEORY

4881 (ERDA-tr—95) **Methods of thermal calculation of underground thermal boilers.** Shcherban, A.N.; Kremnev, O.A.; Tsyrul'nikov, A.S.; Shurchkov, A.V.; Ryzhenko, I.A.; Kononenko, G.N.; Morozov, Yu.P.; Merzlyakov, E.I.; Kozlov, E.M. Dec 1975. Translation by W.J. Grimes of Metody teplovogo rascheta podzemnykh teplovykh kotlov. 46p. Dep. NTIS $4.00.

A model is given for systems with artificial circulation of a heat transfer medium through underground permeable layers, created for the purpose of extracting the deep heat in the earth. An analysis is made of the thermal and hydrodynamic processes using two flow models: plane-linear filtration and filtration with axial symmetry (plane-radial). (LS)

ROCK-WATER-GAS INTERACTIONS

4882 (LBL—4415) **Polymerization kinetics and equilibria of silicic acid in aqueous systems.** Marsh, A.R. III; Klein, G.; Vermeulen, T. (California Univ., Davis (USA). Dept. of Engineering). Oct 1975. Contract W-7405-ENG-48. 177p. Dep. NTIS $8.50.

Thesis.

The polymerization of silicic acid, or dissolved silica, is believed to have a major effect in the deposition of silica scale from geothermal brines. In this research, significant properties of silica in aqueous solution were reviewed, and equilibrium concentrations and polymerization rates at 25°C were measured for total SiO_2 concentrations from 350 to 900 ppM and pH's from 4 to 10. The results indicate that polymerization proceeds by a reaction between neutral and ionized silicic acid molecules and is strongly dependent on pH. The acid strength of polymeric silicic acids increases significantly with molecular weight, producing autocatalysis of the polymerization process by increasing the amount of ionized acid at any given pH. Polymerization occurs fastest when there are equal concentrations of neutral and ionic species. A comprehensive view of silicic acid behavior that clarifies many previous observations and interpretations was developed. Preliminary conclusions are drawn on the mechanisms of scale formation and factors affecting its rate of growth. Monosilicic acid is found to establish a solubility equilibrium with polymeric and colloidal silica, independent of pH, equal to 0.0015 M (or 90 ppM SiO_2) at 25°C. Low-molecular-weight silicic acid polymers exhibit rapidly diminishing equilibrium solubilities; for example, $[Dimer]/[Monomer]^2 = 94\ M^{-1}$. In addition, the standard colorimetric technique for silica determination, which has been widely misinterpreted in the past, was extensively examined and its limitations defined. (auth)

OTHER

4883 (BNWL—1942(Vol.1)) **User manual for GEOCOST: a computer model for geothermal cost analysis. Volume I. Steam cycle version.** Huber, H.D.; Bloomster, C.H.; Walter, R.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Nov 1975. Contract E(45-1)-1830. 145p. Dep. NTIS $7.00.

A computer model called GEOCOST has been developed at Battelle, Pacific Northwest Laboratories, to rapidly and systematically calculate the potential costs of geothermal power. GEOCOST combines both technical processes and economic factors into one systematic framework and provides the flexibility to individually or collectively evaluate their economic impacts. The version of GEOCOST in this report simulates the production of electricity using a steam power conversion cycle based upon either a dry steam or hydrothermal resource. Future extensions to the model will simulate the production of electricity using other power conversion technologies, including binary fluid cycles, combined binary fluid cycles and steam, and the total flow concept. (auth)

4884 (LBL—4420) **National Geothermal Information Resource.** Phillips, S.L.; Fair, J.A.; Henderson, F.B.; Trippe, T.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-ENG-48. 19p. (CONF-751068—1). Dep. NTIS $4.50.

From Annual meeting of the Geological Society of American and Associated Societies; Salt Lake City, Utah, USA (20 Oct 1975).

The objective of the National Geothermal Information Resource (GRID) program is mainly to collect, organize, and disseminate evaluated data on the following six major categories of geothermal science and technology: (1) physical chemistry, (2) exploration and evaluation, (3) utilization, (4) environmental aspects, (5) institutional considerations, and (6) reservoir characteristics. A description is given of the information contained in these categories and examples of current activities are given. Included also is a brief description of the computer-aided document file. (LS)

WIND ENERGY

4885 (ERDA—84) **Federal Wind Energy Program. Summary report.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Solar Energy). Oct 1975. vp. Dep. NTIS $5.45.

This paper presents a brief overview of the Federal research and development activities in the field of wind energy and includes abstracts of the individual projects which comprise the program. (auth)

WIND ENERGY ENGINEERING

APPLICATIONS

4886 **Hydrogen as energy storage element.** Zelby, L.W. (Univ. of Oklahoma, Norman). pp 339-343 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

A residential wind-driven power system, using hydrogen for storage, is described. The advantages of the system are that it is self-contained, and utilizes off-the-shelf components. (6 references) (auth)

TURBINE DESIGN AND OPERATION

4887 (SAND—75-0431) **Darrieus turbine: a performance prediction model using multiple streamtubes.** Strickland, J.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 38p. Dep. NTIS $5.00.

A multiple streamtube performance prediction model for the Darrieus turbine is presented. This model is shown to predict the performance of small-scale rotors, for which test data is available, much more accurately than the single streamtube model. The model is capable of predicting the overall rotor power output and the distribution of aerodynamic forces along the rotor blades. The model can be used to study the effects of rotor geometry variations such as blade solidity, blade taper, and variations in rotor height-to-diameter ratios. In addition, spacial variations in freestream velocity such as that produced by atmospheric wind shear can be easily incorporated into the model. (auth)

4888 **Effect of atmospheric turbulence on windmill performance.** Base, T.E. (Univ. of Western Ontario, London). pp 87-105 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

Theoretical and experimental studies have been made to determine the effects of free stream turbulence structure on the performance of a simple airscrew windmill. A modified blade element method was developed to predict the fluctuating life forces on the rotor blades and computed vortex models of turbulence were used to represent the fluctuating velocity field. Eventually the computer program will enable large rotor diameter windmill performance studies to be conducted and also comparisons to be made with small test rotors. (22 references). (auth)

4889 **Wind capture and diversion through pneumatic energy recovery with large capacity aerogenerators.** Coulter, P.E. (Florida International Univ., Miami). pp 183-196 of In Hydrogen energy. Part A. Veziroglu, T.N. (ed.). New York; Plenum Publishing Corp. (1975).

From Hydrogen economy Miami energy conference; Miami Beach, Florida, USA (18 Mar 1974).

See CONF-740306—PA.

An investigation of a novel design approach to capturing and containing wind in a useable energy form in a 1.5 to 2.5 megawatt power range is described. Rotor blade, air entrainment

and transmission, and tower design are graphically described. Methods of energy conversion and output reliability are discussed, followed by concluding remarks concerning research and development needs relative to anticipated application of the large capacity aerogenerator. (auth)

POWER CONVERSION SYSTEMS

4890 **Electrical generating equipment and electric utility requirements for high-power wind generator systems.** Romanelli, P.J. (General Electric Co., Valley Forge, PA). pp 1251-1257 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The National Science Foundation and NASA's Lewis Research Center are cooperating on a five-year Wind-Energy Program, the objective of which is to provide the technology for cost competitive wind-driven electric-power generation. The five-year program provides for development of large scale (100—3000 kW) systems and advancing technology via supporting research and technology. General Electric under contract to NASA-Lewis (NAS 3-19403) is involved in one aspect of this effort. This contract covers conceptual design, parametric analyses and preliminary design of Wind Generator Systems (WGS) for electric utility applications. In conceptual design, various approaches were investigated and trade-offs conducted to determine the most cost effective designs. Parametric analyses have been conducted to optimize the design and determine the cost sensitivity of the design to the parameters over the range of powers considered. Preliminary design will define system detail and provide more accurate performance and cost analyses. 10 references. (auth)

ELECTRIC POWER ENGINEERING

POWER GENERATION

4891 (CONF-751213—1) **Bench-scale model tests of a fluidized bed furnace for the MIUS coal-fired closed cycle gas turbine.** Holcomb, R.S. (Oak Ridge National Lab., Tenn. (USA)). 1975. 21p. Dep. NTIS $4.50.

From 4. international conference on fluidized bed combustion; McLean, Virginia, USA (9 Dec 1975).

Flow visualization studies were performed on a small-scale Plexiglas model of a coal-burning fluidized bed furnace that has been designed as a heat source for a closed cycle gas turbine total energy system for the HUD-MIUS Program. The test model was 10 in. square with a tube bundle of $^1/_4$ in. OD tubes 6 rows deep. The bed material was limestone with a mean particle size of 370 μm and a static bed height of 1 ft. The following results were obtained: a static region of bed material can be used as thermal insulation on the bed plate and around the turbine air manifolds; the minimum velocity for solids mixing at the wall was 1.75 ft/sec, allowing a 3:1 turndown of the furnace; the bed pulsation frequency was 2-3 cycles/sec over the operating range of air velocity. (auth)

4892 (CONF-751213—2) **Conceptual design of a coal-fired gas turbine for MIUS applications.** Fraas, A.P.; Holcomb, R.S. (Oak Ridge National Lab., Tenn. (USA)). 1975. 55p. Dep. NTIS $5.50.

From 4. international conference on fluidized bed combustion; McLean, Virginia, USA (9 Dec 1975).

Phase II of the program to develop a coal-fired gas turbine for MIUS applications was initiated in January 1975 following HUD and OCR approval of the Phase I study which concluded that a closed cycle gas turbine coupled to a fluidized bed coal combustion chamber appears to give the most promising system for coal-fueled MIUS installations. The objective of Phase II was to evolve a firm conceptual design and cost estimate of an experimental unit designed to investigate the feasibility of the concept. This report summarizes the information presented in eleven topical reports which have been prepared to present the results of the principal elements of the Phase II study. (auth)

COOLING SYSTEMS

4893 (COO—2500-1) **Advanced dry cooling tower concept. Technical progress report, September 1974—August 1975.** Glicksman, L.R. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). May 1975. Contract AT(11-1)-2500. 13p. Dep. NTIS $4.50.

Progress is described in the design and testing of a cooling tower employing a heat exchanger with wet-type packing modified to reduce the amount of evaporation. Proposed activities are also described. (DG)

4894 (ERDA—74) **Method for optimizing and evaluating indirect dry-type cooling systems for large steam-electric generating plants.** Mitchell, R.D. (Beck (R.W.) and Associates, Denver, Colo. (USA)). Jun 1975. Contract AT(04-3)-848. 399p. Dep. NTIS $10.60.

The computer program BECKDRY is described, which was written to assist in performing economic feasibility studies regarding the use of indirect dry-type cooling systems for large, steam-electric generating plants as well as in conducting further research on such systems. The output from BECKDRY is sufficiently detailed for the program to serve as an effective preliminary design tool. (auth)

4895 (K-GD—1330) **Environmental aspects of cooling tower operation.** Jallouk, P.A.; Kidd, G.J.; Shapiro, T.; Taylor, F.G. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1973. 26p. (CONF-750967—7). Dep. NTIS $4.50.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

A description is given of studies to determine the amounts and distribution of chromium and zinc discharged to the environment as a result of cooling tower operation at the Oak Ridge Gaseous Diffusion Plant. (DG)

4896 (ORNL-TM—4416) **Prediction of the temperature distribution in an irregularly shaped, partially mixed, closed-cycle cooling reservoir.** Mitchell, M.E. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 39p. Dep. NTIS $4.00.

Existing cooling pond performance data were reviewed with the objective of determining the factors influencing the cooling effectiveness--defined as the ratio of the excess pond temperature anticipated for an ideal, slug-flow pond to the observed temperature rise. Of the eight applicable cases examined, three were found to exhibit nearly 100 percent performance while five were clearly less than 100 percent effective. The lowest effectiveness observed was 33 percent. While several parameters obviously influence cooling effectiveness, sufficient data were available to determine the effects of only two--wind velocity and heat load. Winds in excess of 7 or 8 mph were found to inhibit the natural convective spread of the heated effluent and thus reduce the cooling effectiveness, while higher heat loads were found to increase cooling effectiveness by increasing the natural convective spread of the effluent. A computational procedure is described appropriate for a closed-cycle system composed of a series of cooling lakes with an arbitrary number of sidearms. Sample calculations are presented for a case involving four cooling lakes arranged in series, each with a number of sidearms. Computed surface temperature rises are compared with the ideal, slug-flow case to determine the cooling effectiveness for this case. (auth)

POWER PLANT COMPONENTS

4897 (CONF-750977—, pp 5.1-5.24) **Some recent improvements of automatic generation control of drum type boilers.** El-Abiad, A. (Purdue Univ., West Lafayette, IN); Keyhani, A. 1975.

From 2. power plant dynamics, control and testing symposium; Knoxville, Tennessee, USA (3 Sep 1975).

In Proceedings of the second power plant dynamics, control and testing symposium.

Various methods of operation of cycling boiler-turbine units as well as large variations in daily load demands have led to the need for examining the entire power generating load control system to optimize the control system design and to maintain the highest degree of thermal efficiency. The optimal dynamic generation control of fossil-fired generating units is discussed. The boilers are allowed to operate in the variable pressure mode for increased thermal efficiency and reduced thermal stresses during cycling operations. One-step-ahead load demand of the system is forecasted by means of stochastic load modeling, and the target pressure is calculated from the target MW load demand. In this setting, the target MW levels are still determined by equal incremental cost theory. However, the MW output of each boiler will be guided toward its assigned economic target level at a rate which will ensure the minimization of the fuel cost. This is to be accomplished by means of constant valve setting. The optimal control problem formulation places bounds on state variables, input variables, and allowable rates of change of state variables for reasons of boiler and combustion safety. (auth)

4898 (CONF-750977—, pp 6.1-6.17) **Modeling and testing fossil-fueled generating units.** Nielsen, R.S.; Berkowitz, D.A. (Mitre Corp., Bedford, MA). 1975.

From 2. power plant dynamics, control and testing symposium; Knoxville, Tennessee, USA (3 Sep 1975).

In Proceedings of the second power plant dynamics, control and testing symposium.

The use of a unit-specific dynamic model plus limited performance testing of the actual fossil-fueled generating unit to obtain specific information on the operating behavior of the unit is discussed and evaluated. The total testing time required to validate a model was just a few hours, a fraction of the time that was required to establish the empirical basis for control system modifications on New Boston No. 2 power generating unit. It is concluded that the model-and-validate approach is successful, and the most economical technique for achieving a comprehensive description of generating unit behavior. (LCL)

4899 (CONF-750977—, pp 7.1-7.10) **Modeling of operating fossil fired power plants: an applications approach.** Bailey, J.M.; Pierce, G.F. (Univ. of Tennessee, Knoxville). 1975.

From 2. power plant dynamics, control and testing symposium; Knoxville, Tennessee, USA (3 Sep 1975).

In Proceedings of the second power plant dynamics, control and testing symposium.

Well formed dynamic models of the process and of the control system of a fossil fuel power plant are required to improve the control of the plant which in turn will improve the reliability of the plant and reduce the cost of generating electric power. Information is presented on efforts to develop suitable models of an existing control loop in an operating fossil-fired plant; evaluate parameters of these models; and illustrate how this information can be utilized to improve plant control, reliability, and economy. (LCL)

4900 (CONF-750977—, pp 8.1-8.11) **Modeling of a boiler at start-up.** Choung, K.C.; Dziubakowski, D.J. (Bailey Meter Co., Wickliffe, OH). 1975.

From 2. power plant dynamics, control and testing symposium; Knoxville, Tennessee, USA (3 Sep 1975).

In Proceedings of the second power plant dynamics, control and testing symposium.

The development of a boiler start-up system model for testing the capability of a control system is described. The process considered is the commonly used once-through type boiler. The modeling approach and equations developed are explained. The model described is an interactive quasi-linear process model in which the nonlinearities of the process variables are considered by insertion of programmed input reference functions internal to the model. These reference functions represent a nominal start-up trend of the inputs. When the model is connected to a control system, deviations in the model inputs from their programmed reference values are used as inputs to pertinent transfer functions and result in proper dynamic movement of the model output. This approach greatly simplifies the hardware construction of the model while meeting the objectives of preventing polarity, trend and some gross pretuning capability of a control system. (LCL)

4901 (CONF-750977—, pp 9.1-9.13) **Axial flow fans for the prevention of furnace implosion damage.** Smoak, R.A. (Babcock and Wilcox, Lynchburg, VA); Lansing, E.G. 1975.

From 2. power plant dynamics, control and testing symposium; Knoxville, Tennessee, USA (3 Sep 1975).

In Proceedings of the second power plant dynamics, control and testing symposium.

A furnace implosion is defined as an occurrence of an excessively low furnace gas side pressure which causes boiler setting damage due to forces in excess of yield. Furnace implosions have been caused by master fuel trips (MFT), control system and actuator malfunctions, and operator error. In all cases, the primary cause of all furnace implosion damage to date can be directly related to the characteristics of the induced draft (ID) fans. To limit the ID fan head capability, therefore, becomes a primary concern in preventing furnace implosions. The fans described and studied by this model are the variable pitch blade axial flow fans. The axial flow fan has several operating advantages over radial flow fans of comparable ratings, and the axial flow type fan offers higher operating efficiencies for utility boiler application. It is concluded that the characteristics of axial flow fans reduce the probability of a furnace implosion caused by an MFT. The lower fan head at low flow reduces the probability of furnace setting damage under all conditions. Further, the stall characteristic of the fan makes a major difference for fast fuel trips. Further work should be done to examine the starting parallel fans and study the effect of damper maloperation. (LCL)

4902 (CONF-750977—, pp 19.1-19.21) **Parameter identification of low-order boiler models for dynamic stability analysis.** Park, C.U.; Herget, C.J. (Iowa State Univ., Ames). 1975.

From 2. power plant dynamics, control and testing symposium; Knoxville, Tennessee, USA (3 Sep 1975).

In Proceedings of the second power plant dynamics, control and testing symposium.

Results are presented of studies performed for the verification and parameter identification of a low-order boiler model from actual operating data. The model chosen for identification and verification is a linear fourth order system with eight unknown parameters and two inputs and two outputs. The inputs are coal flow rate and control valve opening area; the outputs are steam flow rate to the turbine and throttle pressure. The model is intended for use in stability studies over the time interval of approximately one-half minute to a few minutes following a disturbance in the system. The criterion for parameter adjustment is a least squared error fit between the measured data and the model output. The results are presented in the form of several figures which demonstrate that the model response represents the actual response very closely. (auth)

POWER TRANSMISSION AND DISTRIBUTION

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

4903 (BNL—19839) **Dielectric design considerations for a flexible superconducting power transmission cable.** Forsyth, E.B.; McNerney, A.J.; Muller, A.C. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 11p. (CONF-750716—4). Dep. NTIS $4.00.

From International cryogenic materials conference; Kingston, Ontario, Canada (22 Jul 1975).

4904 (BNL—19849) **Considerations of voltage drop and losses in the design of helically-wound superconducting ac power transmission cables.** Morgan, G.; Forsyth, E.B. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 15p. (CONF-750716—3). Dep. NTIS $4.00.

From International cryogenic materials conference; Kingston, Ontario, Canada (22 Jul 1975).

NUCLEAR POWER PLANTS

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

4905 (BNWL-B—426) **Electric power transmission for a Hanford Nuclear Energy Center (HNEC).** (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-1830. 64p. Dep. NTIS $5.45.

The major issues examined in the comparison of the DIST and HNEC transmission concepts are: (1) type of transmission to be employed and an assessment of its technical feasibility, (2) availability of rights-of-way, (3) economics, (4) environmental impact, and (5) overall reliability of the transmission system. The type of transmission selected for bulk power transfer from an HNEC for the time period studied is overhead AC, 500 kV double or single circuit, a voltage currently used in the PNW system. This type of system can accommodate growth up to at least 23,000 MW of thermal capacity at an HNEC. Significant additional transmountain capacity needs would require 1100 kV transmission, which should be technologically proved by the end of the 1970s. (auth)

4906 (BNWL-B—458) **Hanford Nuclear Energy Center: an interim conceptual study.** (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1975. Contract E(45-1)-1830. 62p. Dep. NTIS $5.45.

A description of the Hanford Nuclear Energy Center (HNEC) concept is presented. The technical and socioeconomic factors supporting the conceptual study are reviewed. 14 references. (DCC)

4907 (BNWL-SA—5557) **Experimental verification of stored energy calculations.** Hann, C.R.; Christensen, J.A.; Lanning, D.D.; Marshall, R.K.; Williford, R.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 15p. (CONF-750961—1). Dep. NTIS $4.50.

From 3. annual water reactor safety information exchange; Germantown, Maryland, USA (29 Sep 1975).

A description is provided of irradiation tests designed to provide data needed to verify existing steady state fuel performance codes. The tests are being conducted in the Halden Reactor, and are designed to provide data pertinent to stored energy calculations over a range of linear heat ratings utilized in contemporary power reactors. (auth)

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

4908 (ANCR—1223) **Loft fuel modules design, characterization, and fabrication program.** Russell, M.L. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Sep 1975. Contract E(10-1)-1375. 90p. Dep. NTIS $5.45.

Progress is summarized in the areas of determination of fundamental high-temperature reactor material properties; design invention related to in-core instrumentation attachment; implementation of advanced and/or unique fuel bundle characterization techniques; implementation of improved fuel bundle fabrication techniques; and planning and execution of a multimillion dollar design, characterization, and fabrication program for pressurized water reactor fuel. (auth)

4909 (BAW—3647-35) **Physics verification program. Part IV, Task 1. Quarterly technical report, April—June 1975.** Baldwin, M.N. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Research and Development Div.). Aug 1975. Contract AT(11-1)-3109. 31p. Dep. NTIS $5.00.

The reactivity and power perturbation effects of poison and neutral pins in mockups of 15 by 15 fuel assemblies are being measured. The experimental facility—a water-moderated, 4 percent enriched UO_2 lattice—is arranged to mock up the fuel assemblies of the Consolidated Nuclear Steam Generator (CNSG) core. (auth)

4910 (CENPD—67(Rev.1)(Add.2)) **Iodine decontamination factors during PWR steam generation and steam venting. Topical report.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Aug 1975. 20p. Combustion Engineering, Inc., Windsor, CT.

This addendum submits responses to the NRC request for additional information on the Topical Report CENPD-67, Revision 1, entitled "Iodine Decontamination Factors During PWR Steam Generation and Steam Venting." Each request for information is provided with its appropriate response following. (auth)

4911 (CONF-750607—36) **Temperature measurement on Zircaloy-clad fuel pins during high-temperature excursions.** Meservey, R.H. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 2p. Dep. NTIS $4.50.

From American Nuclear Society meeting; New Orleans, Louisiana, USA (8 Jun 1975).

Special thermocouples and attachment techniques developed for use in measuring surface temperatures of Zircaloy-clad PWR reactor fuel pins during high temperature excursions are described. (auth)

4912 (WARD-MRP—144) **Pressurized Water Reactor Project. Technical progress report for the period January 26, 1975—July 25, 1975.** (Bettis Atomic Power Lab., West Mifflin, Pa. (USA)). 1975. Contract E(36-1)-GEN-14. 19p. Dep. NTIS $4.50.

Shippingport PWR Core 2, Seed 2 has remained shutdown since February 4, 1974, following a failure of the main unit turbine generator. Defueling of PWR-2 continued with head area component disassembly, main omega seal weld cutting, and removal of the reactor vessel head. Plant conditions are being maintained to support the defueling operation. The 1A, 1C, and 1D loops are isolated from the reactor vessel and in a dry layup condition. The 1B loop is open to the reactor vessel. The 1B loop, reactor vessel, and pressurizer are in a partially drained condition. A nitrogen atmosphere is being maintained in the 1B loop. The reactor vessel water level is being maintained within a narrow control band. Routine periodic preventative maintenance work is in progress. The 1A Reactor Coolant Pump was removed, sent off-site for refurbishment, and reinstalled. The 1A heat exchanger was removed and a spare unit placed into its position. Work has begun to remove the 1D heat exchanger for replacement with another spare unit. (auth)

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

4913 (GA-A—13301) **Gas turbine HTGR program. Quarterly progress report for the period October 1, 1974—December 31, 1974.** (General Atomic Co., San Diego, Calif. (USA)). 31 Jan 1975. Contract AT(04-3)-167. 149p. Dep. NTIS $7.60.

4914 (GA-A—13506) **HTGR fuel performance.** Harmon, D.P.; Dahlberg, R.C.; Schleifer, P.; Finkbeiner, R. (General Atomic Co., San Diego, Calif. (USA)). 1 Oct 1975. Contract E(04-3)-167. 16p. (CONF-751030—1). Dep. NTIS $4.00.

From International nuclear industries fair; Basel, Switzerland (7 Oct 1975).

The reference fuel for the thorium cycle HTGR is composed of BISO-coated fertile particles and TRISO-coated fissile particles. These particles are blended together and bonded into fuel rods with a carbonaceous matrix. The fuel rods are then inserted into graphite fuel blocks. Results of irradiation test programs are presented. (auth)

4915 (GA-A—13709) **Gas turbine HTGR for economical dry cooling or high-efficiency combined cycle.** Krase, J.M. (General Atomic Co., San Diego, Calif. (USA)). 1 Oct 1975. Contract E(04-3)-167. 26p. (CONF-751119—2). Dep. NTIS $5.00.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

The Gas Turbine High Temperature Gas-cooled Reactor (GT- HTGR) makes use of a helium-cooled graphite core to provide hot helium to a closed-cycle gas turbine power conversion system which operates on the reactor coolant helium. The helium gas turbines drive conventional electric generators to produce the electric output of the plant. The High Temperature Gas-cooled Reactor (HTGR) core, which is also used in the GT-HTGR, has been developed for commercial application in large central stations with a steam turbine-generator. (auth)

4916 (LA—6062-MS) **Development program for the high-temperature nuclear process heat system.** Jiacoletti, R.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. Contract W-7405-ENG-36. 22p. Dep. NTIS $4.00.

A comprehensive development program plan for a high-temperature nuclear process heat system with a very high temperature gas-cooled reactor heat source is presented. The system would provide an interim substitute for fossil-fired sources and ultimately the vehicle for the production of substitute and synthetic fuels to replace petroleum and natural gas. The dwindling domestic reserves of petroleum and natural gas dictate major increases in the utilization of coal and nuclear sources to meet the national energy demand. The nuclear process heat system has significant potential in a unique combination of the two sources that is environmentally and economically attractive and technically sound: the production of synthetic fuels from coal. In the longer term, it could be the key component in hydrogen production from water processes that offer a substitute fuel and chemical feedstock free of dependence on fossil-fuel reserves. The proposed development program is threefold: a process studies program, a demonstration plant program, and a supportive research and development program. Optional development scenarios are presented and evaluated, and a selection is proposed and qualified. The interdependence of the three major program elements is examined, but particular emphasis is placed on the supportive research and development activities. A detailed description of proposed activities in the supportive research and development program with tentative costs and schedules is presented as an appendix with an assessment of current status and planning. (auth)

4917 (MRR—145, pp 109-129) **Partial current balance method: a new computational method for the solution of multidimensional neutron diffusion problems.** Burns, T.J. (Oak Ridge National Lab., TN); Dorning, J.J. Mar 1975.

From Joint NEACRP/CSNI specialists' meeting on new developments in three dimensional neutron kinetics and review of kinetics benchmark calculations; Garching, F.R. Germany (22 Jan 1975).

In Proceedings of the joint NEACRP/CSNI specialists' meeting.

A new computational method for the solution of multidimensional neutron diffusion problems which is based on local balances of partial currents is described. After briefly motivating the ideas used in the method, the formalism is reviewed. The technique used for the solution of the final equations via local expansions is then described, and the resulting matrix equations are developed. The iteration schemes which were employed in the initial calculations are described. Computational results for two simple one-dimensional HTGR models and for a simple two-dimensional HTGR model are reported and compared with finite element and finite difference calculations for accuracy and computing time. In all cases studied, the partial current balance method compared very favorably with both these widely used methods. Some advantages of the partial current balance formulation are discussed. (auth)

4918 (ORNL-TM—5011) **Irradiation performance of HTGR fuel rods in HFIR experiment HRB-6.** Homan, F.J.; Long, E.L. Jr.; Montgomery, B.H.; Hamner, R.L.; Valentine, K.H. (Oak Ridge National Lab., Tenn. (USA)). Dec 1975. Contract W-7405-eng-26. 49p. Dep. NTIS $5.45.

The HRB-6 Capsule was irradiated in the RB-5 facility of the High Flux Isotope Reactor (HFIR) for eight cycles. The primary purpose of this experiment was to test the then reference recycle fissile fuel—Bisco coated mixed thorium-uranium oxide. Among the several secondary objectives was to determine whether there was any difference in irradiation performance of ^{233}U and ^{235}U. Experiment HRB-6 was the first test of fully enriched (93 percent) ^{235}U in HFIR tests. Both slug injection and extrusion fabrication techniques were used to prepare specimens for this test. No detectable difference between ^{233}U and ^{235}U irradiation performance could be seen from this experiment. The migration rates for the mixed oxide kernels measured for the HRB-6 specimens were consistent with such measurements made on similar kernels in other experiments. Analysis of the entire body of data on thermal migration for mixed oxide fissile kernels later led to the conclusion that this fuel was a marginal performer, and ultimately was replaced as the reference fuel by a uranium oxycarbide fissile kernel loaded from ion exchange resins. The observation of identical performance for ^{233}U and ^{235}U in the mixed oxide system was very important to the fuel development program. The recycle fuel development efforts have continued to use ^{235}U in subsequent irradiation tests, at considerably less expense than if ^{233}U test specimens were used. The very good performance of the test specimens fabricated using extrusion, relative to those fabricated using slug injection, was noted again in HRB-6. (auth)

POWER REACTORS, BREEDING

4919 (ANL—75-21) **Two-dimensional fluid-hammer analysis by the method of nearcharacteristics.** Shin, Y.W.; Kot, C.A. (Argonne National Lab., Ill. (USA)). May 1975. Contract W-31-109-eng-38. 27p. Dep. NTIS $4.00.

A numerical technique based on the method of nearcharacteristics is considered for solving propagation of fluid-hammer waves in a two-dimensional geometry. The solution is constructed by relating flow conditions by compatibility equations along lines called nearcharacteristics. Three choices are considered in the numerical scheme that are accurate within an error of the order of magnitude of the time step. Since the nearcharacteristics lie in the coordinate planes, the technique provides an efficient method requiring only simple interpolations in the initial plane. On the other hand, the nearcharacteristics fall outside the characteristics cone. Thus the solution procedure directly refers to conditions outside the true domain of dependence. The effect of this is studied through numerical calculation of a simple example problem and comparison with results obtained by a bicharacteristic method. Comparison is also made with existing analytical solutions and experiments. Furthermore, the three solution schemes considered are examined for numerical stability by the vonNeumann test. Two of the schemes were found to be unstable; the third yielded a stability criterion equivalent to that of the bicharacteristic formulation. The stability-analysis results were confirmed by numerical experimentation. (auth)

4920 (ANL-CT—76-7) **Acoustically detected events during treat test R7.** Anderson, T.T.; Gavin, A.P.; Spencer, B.W.; Holtz, R.E. (Argonne National Lab., Ill. (USA)). Jul 1975. 26p. AT.

4921 (ANL-CT—76-14) **Transport of inert gas bubbles in a LMFBR core.** Minkowycz, W.J.; France, D.M.; Singer, R.M. (Argonne National Lab., Ill. (USA)). Aug 1975. 75p. AT.

Conservation equations are derived for the motion of a small inert gas bubble in a large flowing liquid-gas solution subjected to large thermal gradients. Terms which are of second order of magnitude under less severe and steady state conditions are retained thus resulting in an expanded form of the Rayleigh equation. The bubble dynamics is a function of opposing mechanisms tending to increase or decrease bubble volume while being transported with the solution. Diffusion of inert gas between the bubble and the solution is one of the most important of these mechanisms included in the analysis. The analytical model is applied to an argon gas bubble flowing in a weak solution of argon gas in liquid sodium. Calculations are performed for these fluids under conditions typical of normal and abnormal operation of a liquid metal fast breeder reactor (LMFBR) core and the resulting bubble radius, internal gas pressure, and mass of inert gas are presented in each case. An important result obtained indicates that inert gas bubbles reaching the core inlet of an LMFBR will always grow as they traverse the core under normal and extreme abnormal conditions and that the rate of growth is quite small in all cases. (auth)

4922 (ANL-RDP—42) **Reactor Development Program progress report, July—August 1975.** (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. vp. AT.

Progress is summarized in the following research and development areas: Experimental Breeder Reactor No. 2, Hot Fuel Examination Facility, LMFBR Design Support, Instrumentation and Control, Fuels and Materials Development, Reactor Physics, Reactor Safety, and GCFR design. (auth)

4923 (CONF-751101—45) **Gas cooled fast reactor benchmark critical assembly.** Bhattacharyya, S.K.; McKnight, R.D.; Robinson, W.R.; Bohn, E.M.; Rusch, G.K.; Martens, F.H.; LeSage, L.G. (Argonne National Lab., Ill. (USA)). Nov 1975. Contract W-31-109-Eng-38. 6p. Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The GCFR Phase I assembly is the initial Gas-Cooled Fast Reactor Benchmark assembly on the ZPR-9 reactor at Argonne National Laboratory. It represents the first full scale mockup of a GCFR ever assembled. It is a clean, simple geometry benchmark reference for the 300 MW(e) GCFR Demonstration Plant designed by General Atomic Company. A description and the evaluated specifications (zero-excess reactivity critical mass and dimensions) of the benchmark assembly are presented. (auth)

4924 (CONF-751101—48) **Central worth and spectral measurements in the GCFR. Phase I assembly.** Morman, J.A.; Bhattacharyya, S.K.; Smith, D.M.; McKnight, R.D.; Yule, T.J.; Bohn, E.M. (Argonne National Lab., Ill. (USA)). Nov 1975. Contract W-31-109-Eng-38. 6p. Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Central fission and capture rates, the central neutron spectrum and the reactivity worths of small samples were measured at the core center of the GCFR Phase I Assembly, the initial benchmark GCFR mockup assembly. Results of these measurements and comparisons with calculations are reported. (auth)

4925 (CONF-751101—51) **Process technology for the molten-salt reactor ^{233}U—Th cycle.** Hightower, J.R. Jr. (Oak Ridge National Lab., Tenn. (USA)). 1975. 37p. Dep. NTIS $5.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

After a brief description of the design features of the molten-salt breeder reactor, fuel processing for removal of ^{233}Pa and fission products is examined. Some recent developments in processing technology are discussed. (JWR)

4926 (COO—2245-16TR) **Porous body model for predicting temperature distributions in wire wrapped fuel and blanket assemblies of a LMFBR.** Khan, E.U.; Rohsenow, W.M.; Sonin, A.A.; Todreas, N.E. (Massachusetts Inst. of Tech., Cambridge (USA)). Jun 1975. Contract AT(11-1)-2245. 213p. Dep. NTIS $8.75.

Existing methods of thermal analysis of a wire wrapped rod bundle of a Liquid Metal Fast Breeder Reactor are based on the principle of subchannel analysis. A model for thermal transport in wire wrapped rod bundles is developed here. The model is similar in principle to the one which has long been successfully used in chemical engineering for heat and mass transfer in fixed beds of packed solids. By dividing the bundle into two predominant regions and applying the model of a porous body to a LMFBR assembly a simple procedure for calculating temperature distributions in LMFBR fuel and blanket assemblies has evolved. The results obtained were found to predict available data with as good a precision as do the more complex analyses. Correlations for the two empirical constants were obtained as functions of geometric parameters based on an extensive analysis of existing data. The LMFBR fuel assemblies operate in forced convection (negligible natural convection) under steady state conditions whereas the blanket assemblies may operate in forced or mixed convection (combined forced and free convection). Two different formulations of equations, corresponding to these two convection regimes, were developed using the same basic model. The calculation procedure for assemblies in forced convection (called ENERGY I) is considerably simpler than that (ENERGY II, ENERGY III) in mixed convection, where buoyancy effects become important. Therefore it is desirable to use ENERGY I for forced convection (although ENERGY II, III can also be used in forced convection, the computational times are fifteen fold greater). In order to determine when buoyancy effects become important a new criterion is developed. Given the power, the power skew, the operating and geometric characteristics of the bundle, the critical modified Grashof Number predicts when buoyancy effects become important. (auth)

4927 (COO—2245-17TR) **Input parameters to the ENERGY code (to be used with the ENERGY codes manual).** Khan, E.U.;

Rohsenow, W.M.; Sonin, A.A.; Todreas, N.E. (Massachusetts Inst. of Tech., Cambridge (USA)). May 1975. 22p. Dep. NTIS $4.50.

Recommended values of input data required by ENERGY code users are presented. (JWR)

4928 (COO—2245-18TR) **Manual for ENERGY I, II, III computer programs.** Khan, E.U.; Rohesnow, W.M.; Sonin, A.A.; Todreas, N.E. (Massachusetts Inst. of Tech., Cambridge (USA)). May 1975. 113p. Dep. NTIS $6.50.

The ENERGY codes for predicting coolant temperature distributions in LMFBR were wrapped fuel and blanket assemblies are described. The mathematical models, data input, code listings, and sample problems are presented. (JWR)

4929 (COO—2250-2) **LMFBR Blanket Physics Project progress report No. 2.** Forbes, I.A.; Driscoll, M.J.; Rasmussen, N.C.; Lanning, D.D.; Kaplan, I. (eds.). (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). 30 Jun 1971. Contract AT(11-1)-3060. 136p. (MITNE—131). Dep. NTIS $7.00.

This is the second annual report of an experimental program for the investigation of the neutronics of benchmark mock-ups of LMFBR blankets. Work was devoted primarily to measurements on Blanket Mock-Up No. 2, a simulation of a typical large LMFBR radial blanket and its steel reflector. Activation traverses and neutron spectra were measured in the blanket; calculations of activities and spectra were made for comparison with the measured data. The heterogeneous self-shielding effect for ^{238}U capture was found to be the most important factor affecting the comparison. Optimization and economic studies were made which indicate that the use of a high-albedo reflector material such as BeO or graphite may improve blanket neutronics and economics. (auth)

4930 (GA-A—13148) **Gas-Cooled Fast Breeder Reactor. Quarterly report for the period May 1, 1974—July 31, 1974.** (General Atomic Co., San Diego, Calif. (USA)). 26 Sep 1974. Contract AT(04-3)-167. 119p. Dep. NTIS $5.45.

4931 (GA-A—13327) **Heat transfer data base for GCFR core design.** Hopkins, H.C. (General Atomic Co., San Diego, Calif. (USA)). 4 Sep 1975. Contract AT(04-3)-167. 28p. Dep. NTIS $4.00.

The Gas-Cooled Fast Breeder Reactor (GCFR) heat transfer data base is presented as a reference tree with the following branches: GCFR design summaries, heat transfer technology, design reviews, thermal analysis computer codes, and thermal design of other gas-cooled reactors. An extensive bibliography of published heat transfer references, arranged chronologically, and comparative data on other gas-cooled reactors are also included. (auth)

4932 (GA-A—13458) **Gas-Cooled Fast Breeder Reactor. Quarterly progress report for the period February 1, 1975—April 30, 1975.** (General Atomic Co., San Diego, Calif. (USA)). 17 Jul 1975. Contract AT(04-3)-167. 235p. Dep. NTIS $7.60.

4933 (GA-A—13653) **Development of components for the Gas-Cooled Fast Breeder Reactor program.** Dee, J.B.; Macken, T.; Meyer, L. (General Atomic Co., San Diego, Calif. (USA)). 24 Sep 1975. Contract E(04-3)-167. 30p. (CONF-751007—5). Dep. NTIS $4.50.

From IAEA international meeting on gas-cooled reactors; Julich, F.R. Germany (13 Oct 1975).

The purpose of this paper is to present an overview of the principal component design differences, when compared with those of typical HTGRs, and the consequent influences on the GCFR component development programs. Development program plans are discussed and include those for the prestressed concrete reactor vessel (PCRV), the main helium circulator and its supporting systems, the steam generators, the reactor thermal shielding, and the fuel handling system. Facility requirements to support these development programs are also discussed. Studies to date show that GCFR component development continues to appear to be incremental in nature, and the required tests are adaptations of related HTGR test programs. (auth)

4934 (GEAP—13771-15) **Critical experiments and analysis. Fifteenth quarterly report, April—May—June 1975.** (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jul 1975. Contract AT(04-3)-893. vp. AT.

Current activities and technical progress are reported for critical experiments and analysis as applicable to LMFBR commercial plants and the Clinch River Breeder Reactor Plant Benchmark Critical Experiments in ZPPR Assembly 4 and the CRBRP EMC. Additional studies are directed toward the development of LMFBR plant calculational methods that also can be used at the sites of the Clinch River Breeder Reactor to determine the reactor power distribution, reactivity and fuel status, and for consideration of alternative fuel and control management schemes. (auth)

4935 (GEAP—14039-2) **Advanced oxide fuel systems design and trade-off studies. Second quarterly report, December 1974, and January—February 1975.** (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Mar 1975. Contract AT(04-3)-893. 18p. AT.

4936 (GEAP—14054) **Review and evaluation of current aerosol models for LMFBR safety analysis.** Huang, T.C.; Stitt, R.K. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jun 1975. Contract AT(04-3)-893. 52p. AT.

Aerosol behavior models were reviewed and the most significant areas of the models were assessed to determine their adequacy for LMFBR safety analysis. It is concluded from this study that the aerosol behavior models presently available can be utilized to adequately predict aerosol behavior in the reactor containment building, providing the Stokes' correction factor, the gravitational collision efficiency and the boundary layer thickness at the wall can be determined for the size containment being analyzed. However, these models were found to need improvement and revisions before they can be used adequately for evaluation of aerosol behavior in the reactor cover gas region during an HCDA event. The state-of-knowledge as to the processes and controlling phenomena associated with the formation of aerosols from sodium fire, fuel vapor condensation, and fragmentation were studied. A variety of analytical aerosol source models were assessed and the important experimental results were summarized. (auth)

4937 (GEAP—14064) **Influence function algorithm for predicting power distributions and control worths.** Cowan, C.L.; Choong, T.P.; Russell, C.S. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jul 1975. Contract AT(04-3)-893. 53p. AT.

An influence function algorithm for predicting the effects of control rod movements on the three-dimensional power distributions and control worths in LMFBR plants has been specified. The algorithm provides a capability for carrying out rapid fuel management computations which can be utilized in LMFBR fuel burnup scoping studies and in the on-site surveillance, evaluation and planning of reactor performance. The influence function in terms of a practical computational tool is described. Particular emphasis is placed upon the incorporation of the influence function approach in the interpolative fuel management code FUMBLE to provide for the effects of control movements on the fuel burnup calculations. 5 references. (auth)

4938 (HEDL-SA—960(Rev.)) **Some findings from FFTF piping and component design analyses.** Severud, L.K.; Weiner, E.O.; Winkel, B.V. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-2170. 24p. (CONF-750635—1). Dep. NTIS $4.25.

From Meeting of fast reactor thermal transients; Washington, District of Columbia, USA (19 Jun 1975).

A number of questions that have been commonly raised during elevated temperature design of FFTF components and pipelines are identified and discussed. Although the questions do not lend themselves to simple answers, some guidance based on analysis findings is given. Based upon the limited data developed, uniaxial stress relaxation data can give a reasonable pattern of structural creep damage as a function of time. However, the creep damage magnitude may be as much as a factor of two too low. Other geometries and/or loading may show much larger variations between the uniaxial and complex hardware creep damage response. (auth)

4939 (HEDL-SA—986) **Techniques for studying corrosion and deposition of radioactive materials in sodium loops.** Brehm, W.F.; Chulos, L.E.; McGuire, J.C.; Leaf, A.C.; Colburn, R.P. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-2170. 40p. (CONF-750972—1). Dep. NTIS $5.00.

From IAEA specialists meeting on fission and corrosion products in primary systems of LMFBR's; Dimitrovgrad, USSR (8 Sep 1975).

Standard temperature and flow control methods are used for the test loops. Some improvements in temperature control methods for cold traps and coolers have been made and are described. Radionuclide migration through the test loops is monitored during test operation as well as during times when the loops are shutdown. The Ge(Li) diode gamma spectrometer and multichannel analyzer are calibrated using radiochemical standards in piping of identical sizes as used in the loops. An incremental analysis technique has been developed to obtain chemical and radiochemical gradients in the stainless steel test specimens. These gradients arise as the result of nonuniform corrosion of the alloy constituents of stainless steel by the sodium. A calculation method has been devised to combine the results of weight change measurements and the incremental analysis to determine the corrosion rates of each alloy constituent. 7 references. (auth)

4940 (HEDL-TME—74-42) **Gas release vent performance during LMFBR irradiation.** Christensen, J.A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jul 1974. Contract AT(45-1)-2170. 54p. AT.

The use of vents to release He from boron-containing absorber pins is required to achieve substantial improvements in lifetime, performance, and cost of LMFBR control rods. Various types of vents have been evaluated in the laboratory and by testing in EBR-II. The results of in-reactor tests performed to date are described. A nineteen-pin bundle containing fourteen vented pins was irradiated in Row 7 of the EBR-II for 100 EFPD. Top and bottom diving bell type vents plus two types of capillary valve vents (porous plugs and flattened tubes) were included in the test. Results of postirradiation examination and data analyses are presented. (auth)

4941 (HEDL-TME—75-89) **Fuel pellet modeling in the r-z plane.** Bard, F.E.; Watwood, V.E. Jr. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1975. Contract AT(45-1)-2170. 46p. AT.

A two-dimensional analysis of fuel pellets cracking behavior during reactor heatup and cooldown, as well as a two-dimensional analysis of fuel pellet creep behavior during a reactor steady-state operation, is presented. Startup cracking behavior was found to depend upon the creep behavior of the fuel, and coupling of these two effects must be considered in the future. The two-dimensional elastic results indicate that the one-dimensional fuel behavior resulting from plane strain assumption should be used with caution, since the end effects ("belling") of the fuel pellet influences the mid-pellet stress calculation and top edge displacements. (auth)

4942 (LA—6095-MS) **Consequences of sodium bond loss from an LMFBR carbide fuel element.** Kerrisk, J.F. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-ENG-36. 20p. Dep. NTIS $4.00.

The consequences of sodium bond loss from a uranium-plutonium carbide fuel element during normal steady state operation have been assessed. The elements considered are typical of those currently being irradiated in EBR-II, and include elements with and without shroud tubes. The analysis presented is very conservative in that the many simplifying assumptions required were made to predict worse consequences than would be found in a realistic analysis. Following sodium bond loss, fuel melting occurs, but the fuel rapidly resolidifies after slumping out to contact the clad. Even if molten fuel were lost through an existing clad failure, the maximum fuel temperatures attained are below those required to initiate a vapor explosion in the sodium coolant. The small amount of molten fuel that might escape through an existing clad failure would have little or no effect on adjacent elements. (auth)

4943 (LMEC—75-1) **Liquid Metal Engineering Center (LMEC) annual technical progress report, January—December 1974.** (Liquid Metal Engineering Center, Canoga Park, Calif. (USA)). 15 Mar 1975. Contract AT(04-3)-700. 533p. AT.

Information is presented on the development and testing of LMFBR components and systems, including: FFTF pump seal test; FFTF dump heat exchanger testing; FFTF prototype pump testing; FFTF secondary isolation valve testing; materials compatibility in sodium; Sodium Pump Test Facility (SPTF) valve testing and mixing tee water tests; sodium level and pressure transducer testing; proximity transducer testing; electric resistance heater testing; sodium-to-gas leak detection tests; sodium fire suppression; LMFBR materials and component procurement standards; magnesium oxide purity tests; pipe examination after long-term sodium service; vanadium wire method for oxygen analysis; sodium pump failure investigation; Sodium Components Test Loop hydraulic system performance; automatic and machine welding experience; and SPTF feed and drain tank stress analysis. (HDR)

4944 (ORNL-TM—5093) **Needs for development in nondestructive testing for LMFBR and other advanced reactor systems.** McClung, R.W. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 75p. AT.

The needs for development of nondestructive testing techniques and equipment were surveyed and analyzed to resolve problem areas for the Liquid-Metal Fast Breeder Reactor, the Molten-Salt Breeder Reactor and the Advanced Gas-Cooled Reactor. The developmental needs that are broad-based requirements in nondestructive testing and the respective methods and applicable, in general, to all components and reactor systems are discussed. Next in order are the requirements of generic materials and components (e.g., steam generators) that are common to all reactor systems. These are followed by sections specific to materials and components peculiar to each of the three cited reactor systems. The methods-oriented needs and recommendations include improved reliability and quantitativeness, flaw characterization, and data processing as well as many comments specific to such methods as ultrasonics, eddy currents, acoustic emission, radiography, etc. The cited needs common to all reactors include those related to materials properties and degradation, welds, fuels, piping, steam generators, etc. In the sections on specific reactors, the needs of the above (and other) items that are peculiar to the given reactor system are emphasized. The scope of applicability ranges from initial design and material development stages through process control and manufacturing inspection to in-service examination. (auth)

4945 (SAND—75-0223) **Theoretical studies of flash x-ray diagnostics for fuel motion experiments.** Halbleib, J.A. Sr.; Phillips, A.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. 40p. Dep. NTIS $4.00.

The results of preliminary theoretical studies concerning the possible employment of short-pulse, high-current field emission diodes as sources for the flash x-ray diagnostics of fuel-pin motion are reported. The predicted thick-target photon environments are obtained from state-of-the-art coupled electron/photon transport models. Through qualitative figures of merit these environments are used to study the importance of source current and voltage. For a selected experimental configuration a comparison is made between the absolute flash x-ray imaging signals predicted for these environments and Monte Carlo/analytic calculations of absolute fission-gamma backgrounds. These preliminary data suggest that field emission sources operating at voltages in the 1-to 5-MeV range and at currents of the order of 100-kA or greater may be adequate diagnostic sources for test-pin configurations as complex as a full LMFBR subassembly. (auth)

4946 (WAPD-TM—1199) **Flow patterns in high pressure two-phase flow: a visual study of water in a uniformly heated 4-rod bundle (LWBR Development Program).** Williams, C.L.; Peterson, A.C. Jr. (Bettis Atomic Power Lab., West Mifflin, Pa. (USA)). Nov 1975. Contract E(36-1)-GEN-14. 83p. Dep. NTIS $6.00.

Flow patterns that occur in a rod bundle with forced upward flow of boiling water have been photographed. The experimental rod bundle consisted of four vertical 0.25-inch diameter by 24.0 inch long rods arranged in a single row. The tested conditions were: pressure—400 to 2000 psia, mass velocity—250,000 to 4,000,000 lb/hr-ft^2, and heat flux (uniform)—up to 1,600,000 Btu/hr-ft^2. The observed two-phase flow patterns were bubble flow, froth flow, slug flow, and annular flow. The flow patterns were mapped at constant pressure on plots of mass velocity versus flowing quality. (auth)

4947 (WARD-SG—3045-1(Vol.2)) **Alternate Steam Generator Development program. Phase I: summary report, September 1974—December 1974. Volume 2. Evaluation of alternate secondary system fluids for LMFBR plants.** Cooper, M.H.; Lee, P.K. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Oct 1975. Contract E(11-1)-3045. 90p. AT.

The feasibility of mitigating potential sodium-water reactions in the steam generator of the Liquid Metal Fast Breeder Reactor (LMFBR) by substituting a less reactive fluid in the secondary loop was investigated by surveying potential alternate coolants. Physical properties of candidate fluids, including liquid elements, molten salts, simple gases, dissociating gases, organics, and fluid-solid suspensions were tabulated. Performance of these fluids was evaluated on the basis of required heat transfer area and pumping power for a typical steam generator design, chemical reactivity with sodium and water, materials compatibility, thermal stability, and irradiation stability. No suitable fluid superior to sodium was identified for use at the reference plant conditions; Dowtherm A could be substituted for sodium in reduced temperature plants with maximum secondary system temperatures of 427°C (800°F). Lead-bismuth alloy is recommended as a thermal bond in conduction-type alternate steam generator, since it is relatively non-reactive with sodium and water, corrosion is minimal in a non-circulating system, and its vapor pressure is minimal. (auth)

4948 (ANL-Trans—1005) **Methods for studying problems related to liquid sodium flows.** Constantin, J.P.; Huffenus, J.P.; Lambert, P.; Leon, P. 1972. Translation of FRNC-CONF—43. 12p. Dep. NTIS $4.50.

The methods used to study liquid metal circulation problems in sodium cooled reactors are described. The following points are emphasized: isothermal pressure and free-surface flow (head losses, cavitation, surface roughness, gas entrainment); vibration of immersed shells and structures; non-isothermal flow (heat transfer, natural and mixed convection). (8 references) (auth)

4949 (ANL-Trans—1006) **Hydraulic problems in sodium exchangers and repercussion in thermal areas.** Kayser, G.; Boulot, F. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-

Paul-les-Durance (France)). 1972. Translation of CEA-CONF—2046. 15p. Dep. NTIS $4.50.

The thermal consequences due to non-uniform flow in the inlet and outlet zones in an exchanger in a sodium reactor of the Phenix type are considered. Design variations are analyzed. (auth)

4950 (ANL-Trans—1007) **Fast neutron reactors: advancement from initial research to the Phenix Power Plant.** Vendryes, G.; Villeneuve, J.; Faure, F.; Milliat, J.P.; Rozenholc, M. 1973. Translation of CEA-CONF—2640. 20p. Dep. NTIS $4.50.

The pace of development of the fast neutron reactor in France and other countries is compared and related to the development of Light water and High temperature reactors. The various stages of acquisition of knowledge are discussed, and the present position in France is appraised: the demonstration Phenix plant will soon be completed; and the prototype 1200 MW(e) Super Phenix is on the drawing boards. The main choices adopted in the French programme are described and critically reviewed. (auth)

4951 (ANL-Trans—1008) **Towards commercial fast breeder reactors the first 1200 MWe unit.** Banal, M.; Carle, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). 1973. Translation of CEA-CONF—2641. 17p. Dep. NTIS $4.50.

The public probably thinks of these fast breeder reactors in terms of their rising unit capacity: RAPSODIE 20 MW (thermal), raised to 40 MW, PHENIX 25 MWe, and now 1200 MWe. However, the purposes of the project and the framework of construction have been fundamentally different in each case. Design parameters and the development program of the LMFBR are presented. (auth)

4952 (ANL-Trans—995) **Calculations by TRIPOLI of the neutron spectrum in the lower sections of the PHENIX exchanger.** Nimal, J.C.; Vergnaud, T. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). Feb 1973. Translation of CEA-N—1579. 58p. Dep. NTIS $5.50.

Calculations were made to determine the contribution to the activation of the secondary sodium by the neutrons which escape from beneath the side neutron shield of the PHENIX reactor. In the course of this study we have also determined the complete energy spectrum from all points of view of the neutron pathways in order to compare results with those given by other methods. These latter calculations were useless as far as the activation of the secondary sodium was involved since this latter item is due only to the small numbers of neutrons which can get through the shield and still have sufficient energy. The deviations between the results given by TRIPOLI and NIOBE are due for the most part to the very different conditions under which they were calculated. The results are given. (auth)

4953 (ANL-Trans—992) **PHENIX reactor civil engineering technical problems and solutions.** Labat, P.; Lacroix, R.; Magnas, J.P. Translated from *Ann. Inst. Tech. Batim. Trav. Publics;* No. 304, 121-147(Apr 1973). 33p. Dep. NTIS $4.50.

The Phenix Power Plant in Marcoule now nearing completion will be the first industrial fast-neutron reactor to be built in France. The construction required a large-scale civil engineering site which had to meet a number of specific requirements: waterproof substructures with respect to the underground water table, absence of differential settlements between large-scale works, earthquake resistance, air-tight buildings, special forces to be accommodated, considerable overloads. Some original solutions were adopted: steel lining as parts of the strength of the raft and the outside walls, precase prestressed concrete panels joined by post-tension, and bonding of metal framings to prestressed or conventional structures which are partly precast. These arrangements made it possible to meet the required specifications. In particular, the tests for air-tightness of the reactor container gave full satisfaction. (auth)

4954 (ANL-Trans—1004) **Civil engineering and the Phenix Power Plant.** Lacroix, R.; Magnas, J.P. Translated from *Tech. Mod.;* 65: 27-33(Oct 1973). 12p. Dep. NTIS $4.50.

Civil engineering problems encountered in constructing the complex buildings required for the PHENIX power plant are considered: Site problems (sealing substructures to prevent sodium leaks, protection against differential settling due to site non-homogeneity), air-tightness of buildings, strength against earthquakes and high overloads. The permeability of various concretes is discussed. (LTN)

4955 (ANL-Trans—986) **Monitoring the sealing of the components of the Phenix block reactor.** Blanc, B.; Roulliay, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Jul 1975. Translation of CEA-CONF—1896. 16p. Dep. NTIS $4.00.

Among the controls done in the course of assembling the components of the reactor unit of Phenix, the welds in the principal pressure shell, the double casing, and the ceiling were leak tested by using helium. After several reminders concerning the structure of the reactor unit of the Phenix, the methods used for these controls (a method called "venting"), and the nature of the monitoring done are described. (auth)

4956 **Test results prove LMFBR heat exchanger concept.** MacDonald, J.S. (Atomics International Div., Canoga Park, CA). *Energy Int.;* 12: No. 10, 33-36(Oct 1975).

The development and testing programs of the steam generator design to be used in the U. S. LMFBR program are reviewed. (DCC)

REGULATION AND LICENSING

4957 (NUREG/PRDI—75/10) **Power Reactor Docket Information.** (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). Oct 1975. 73p. TIC.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission in support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name. (DCC)

4958 (NUREG/PRDI—75/11) **Power reactor docket information.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Nov 1975. 98p. TIC $1.85.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U. S. Nuclear Regulatory Commission support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name. (DCC)

4959 (RDT-INDEX—(7-75)) **Index of RDT Standards.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Research and Development). 31 Jul 1975. 92p. RSO.

4960 (RDT-INDEX—10(75)) **Index of RDT Standards.** (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. RSO.

4961 (TID—26811(P4)) **Atomic Energy Commission Reports. Volume 4.** (USAEC, Washington, D.C.). 1973. 1439p. GPO $14.70.

The opinions and decisions of the Atomic Energy Commission, Atomic Safety and Licensing Appeal Boards, Atomic Safety and Licensing Boards, Board of Contract Appeals, and the Contract Adjustment Board are presented for the period July 1, 1967 to June 30, 1972. (HDR)

4962 (TID—26811(P7)) **Atomic Energy Commission Reports. Volume 7.** (USAEC, Washington, D.C.). 1975. 1435p. GPO $16.85.

This is the seventh volume of issuances of the Atomic Energy Commission, Atomic Safety and Licensing Appeal Boards, Atomic Safety and Licensing Boards, Board of Contract Appeals, and Contract Adjustment Board and covers the period from January 1, 1974, to June 30, 1974. This volume is made up of reprinted pages from the six monthly issues of the Atomic Energy Commission publication Regulatory Adjudication Issuances and Issuances of the Board of Contract Appeals (RAI), for this time period, arranged in chronological order. Cross references in the text and indexes are to RAI page numbers which are the same as the page numbers in this publication. A separate index for the Board of Contract Appeals is included. (auth)

4963 (TID—26811(P8)) **Atomic Energy Commission Reports. Volume 8.** (USAEC, Washington, D.C.). 1975. 1328p. GPO $15.95.

This is the eighth and final volume of issuances of the Atomic Energy Commission and its Atomic Safety and Licensing Appeal Boards, Atomic Safety and Licensing Boards, and Board of Contract Appeals and covers the period from July 1, 1974, to January 18, 1975. The issuances of the Nuclear Regulatory Commission (NRC) and of the Licensing Boards and Appeal Boards that are now under its cognizance will be published in the future by NRC as NRC Reports. The Board of Contract Appeals became part of ERDA. This volume is made up of reprinted pages from the last six 1974 monthly issues (July—December) plus the final

issue for the period from January 1 to 18, 1975, of the Atomic Energy Commission publication Regulatory Adjudication Issuances and Issuances of the Board of Contract Appeals (RAI). The material is arranged in chronological order. Cross references in the text and index are to RAI page numbers, which are the same as the page numbers in this publication. A separate index for the Board of Contract Appeals is included. (auth)

4964 (ORNL-tr—4041) **Guideline for certification of technical knowledge of nuclear power plant personnel.** 8 Oct 1974. Translation by R.G. Mansfield of UA II 4-513 805/2. 8p. Dep. NTIS $4.50.

Detailed procedures are described by which managers and operators of nuclear power plants must be certified according to German law. (LTN)

4965 (REG/G—1.79(Rev.1)(9-75)) **Preoperational testing of emergency core cooling systems for pressurized water reactors.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Sep 1975. 4p. NUREG.

This guide describes a preoperational test program acceptable to the staff specifically for emergency core cooling systems (ECCS) in pressurized water reactor power plants. Although this guide is applicable to all pressurized water reactors, certain aspects may not be completely applicable to specific nuclear steam supply designs. (auth)

ECONOMICS

FUEL CYCLE

4966 (ERDA—73) **Independent assessment of forseeable problems in the nuclear fuel cycle.** (Stoller (S.M.) Corp., New York (USA)). 18 Apr 1975. Contract AT(49-1)-3695. 290p. Dep. NTIS $7.60.

Information is presented concerning the U. S. nuclear fuel cycle business including investment requirements; nuclear power growth projection; reliability of uranium supply; enrichment facilities; plutonium recycle; safeguards; and insurance. (DCC)

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

4967 (COO—2262-8) **Finite difference solution of the time dependent neutron group diffusion equations.** Hendricks, J.S.; Henry, A.F. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). Aug 1975. Contract AT(11-1)-2262. 198p. (MITNE—176). Dep. NTIS $8.50.

Thesis.

In this thesis two unrelated topics of reactor physics are examined: the prompt jump approximation and alternating direction checkerboard methods. In the prompt jump approximation it is assumed that the prompt and delayed neutrons in a nuclear reactor may be described mathematically as being instantaneously in equilibrium with each other. This approximation is applied to the spatially dependent neutron diffusion theory reactor kinetics model. Alternating direction checkerboard methods are a family of finite difference alternating direction methods which may be used to solve the multigroup, multidimension, time-dependent neutron diffusion equations. The reactor mesh grid is not swept line by line or point by point as in implicit or explicit alternating direction methods; instead, the reactor mesh grid may be thought of as a checkerboard in which all the "red squares" and "black squares" are treated successively. Two members of this family of methods, the ADC and NSADC methods, are at least as good as other alternating direction methods. It has been found that the accuracy of implicit and explicit alternating direction methods can be greatly improved by the application of an exponential transformation. This transformation is incompatible with checkerboard methods. Therefore, a new formulation of the exponential transformation has been developed which is compatible with checkerboard methods and at least as good as the former transformation for other alternating direction methods. (auth)

4968 (DP-MS—75-53) **Determination of diffusion parameters using response matrix theory.** Pryor, R.J.; Sicilian, J.M. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Nov 1975. Contract AT(07-2)-1. 12p. (CONF-751101—42). Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

A method is presented which provides the accuracy of the response matrix method, but without requiring the development of a response matrix reactor code. The method is used to determine diffusion parameters which, when used in conventional reactor diffusion codes, provide the same results as a response matrix reactor code. (auth)

4969 (MRR—145) **Proceedings of the joint NEACRP/CSNI specialists' meeting on new developments in three-dimensional neutron kinetics and review of kinetics benchmark calculations, Garching, 22nd—24th January 1975.** (Technische Univ. Muenchen, Garching (F.R. Germany). Lab. fuer Reaktorregelung und Anlagensicherung). Mar 1975. 573p. (CONF-750134—).

From Joint NEACRP;CSNI specialists' meeting on new developments in three dimensional neutron kinetics and review of kinetics benchmark calculations; Garching, F.R. Germany (22 Jan 1975).

Separate abstracts were prepared for each of the 14 papers included. All abstracts are included in NSA and one is presented in ERA. (JWR)

COMPONENTS AND ACCESSORIES

4970 (ORNL—5021) **Theoretical and experimental stress analyses of ORNL thin-shell cylinder-to-cylinder model 2.** Gwaltney, R.C.; Bolt, S.E.; Bryson, J.W. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 181p. Dep. NTIS $7.60.

Model 2 in a series of four thin-shell cylinder-to-cylinder models was tested, and the experimentally determined elastic stress distributions were compared with theoretical predictions obtained from a thin-shell finite-element analysis. Both the cylinder and the nozzle of model 2 had outside diameters of 10 in., giving a d_o/D_o ratio of 1.0, and both had outside diameter/thickness ratios of 100. Sixteen separate loading cases in which one end of the cylinder was rigidly held were analyzed. An internal pressure loading, three mutually perpendicular force components, and three mutually perpendicular moment components were individually applied at the free end of the cylinder and at the end of the nozzle. In addition to these 13 loadings, 3 additional loads were applied to the nozzle (in-plane bending moment, out-of-plane bending moment, and axial force) with the free end of the cylinder restrained. The experimental stress distributions for each of the 16 loadings were obtained using 152 three-gage strain rosettes located on the inner and outer surfaces. All the 16 loading cases were also analyzed theoretically using a finite-element shell analysis. The analysis used flat-plate elements and considered five degrees of freedom per node in the final assembled equations. The comparisons between theory and experiment show reasonably good general agreement, and it is felt that the analysis would be satisfactory for most engineering purposes. (auth)

4971 (ORNL—5070) **Noise radiation from natural-draft cooling towers for nuclear power plants.** Carley, T.G. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 27p. Dep. NTIS $4.00.

A procedure for computing the noise levels in the vicinity of natural-draft cooling towers is presented. The noise levels are computed in overall and octave band levels with A-weighting and with no weighting. Attenuation of the noise by wave spreading, atmospheric absorption, barrier screening, vegetation, and wind and temperature gradients are included. The procedure is applied to a nuclear power plant served by four cooling towers and to a nuclear energy center with forty cooling towers. (auth)

4972 (RDT-F—3-6T(10-75)) **Nondestructive examination (supplement to ASME boiler and pressure vessel code, section V).** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Research and Development). Oct 1975. 15p. RSO.

1974 edition with addenda through summer 1975.

Criteria are presented for radiographic examination, ultrasonic examination, liquid penetrant examination, magnetic particle examination, and leak testing. (JWR)

FUEL ELEMENTS

4973 **Measured and calculated fission-product poisoning in neutron-irradiated uranium-233.** Gunst, S.B.; Connor, J.C.; Conway, D.E. (Westinghouse Electric Corp., West Mifflin, PA). *Nucl. Sci. Eng.*; **58**: No. 4, 387-413(Dec 1975).

Samples of ^{233}U and of natural thorium have been irradiated in high neutron-flux facilities, in both soft and hard neutron spectra, and for both short and long exposure times. Included are exposures resulting in depletions of more than 90 percent of the ^{233}U in the fissile material and burnups of more than 30,000 MWd/MT in the fertile material. Fission-product poison cross sections in two energy groups (thermal and epithermal) exhibit differences between measurement and calculation that are believed to be attributable to a lack of adequate information on important fission products in the literature. Experimental results for transient absorbers in irradiated ^{233}U give at least 20,000 b for the neutron absorption resonance integral of ^{149}Pm. This is a factor of 15 higher than that obtained by a 1/v extrapolation of the thermal cross sections. For transient ^{135}Xe, the measured absorption is 7.5 percent higher than that calculated using ENDF/B-IV data. Information is also provided concerning such matters as fission yields and neutron absorption of neodymium isotopes, the existence of significant transient fission-product poisons other than ^{135}Xe and ^{149}Sm, and the shielding of ^{233}U by ^{232}Th. Such shielding suggests the need for a change in the energy dependence of the ^{232}Th thermal-neutron cross section. (auth)

CONTROL SYSTEMS

4974 (ANL-CT—74-19) **Development of self-actuated shutdown systems for LMFBR plants. Final report.** (Argonne National Lab., Ill. (USA)). Jul 1974. 101p. AT.

4975 (ANL-CT—76-2) **Development of self-actuated shutdown systems for LMFBR plants. Final report.** Josephson, J.; Huebotter, P.R.; Sowa, E.S.; van Erp, J.B.; Pizzica, P.A.; Barthold, W.P.; Turski, R.B.; Schumar, J.F.; Parr, E.D.; Eggen, D. (Argonne National Lab., Ill. (USA)). Aug 1975. 190p. AT.

4976 (DP-MS—75-60) **Control algorithms in a coarse-mesh rebalance framework.** Gregory, M.V.; Honeck, H.C. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Nov 1975. Contract AT(07-2)-1. 24p. (CONF-751101—44). Dep. NTIS $4.25.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Control algorithms for power shaping calculations and critical rod bank position searches are described. The algorithms allow a flux computation module using a finite difference solution of the few-group neutron diffusion equations with coarse-mesh rebalancing to be directly extended to control calculations. The control algorithms are formulated as an extension of the standard critical buckling search by recasting the procedure for calculating the eigenvalue. A comparison of the power shaping calculation with an equivalent k/sub eff/ calculation demonstrates that the former requires approximately the same number of outer iterations as the latter. (auth)

ENVIRONMENTAL ASPECTS

4977 (BNL—20579) **Noise from cooling towers of power parks.** Zakaria, J.; Moore, F.K. (Brookhaven National Lab., Upton, N.Y. (USA)). 14 Oct 1975. 26p. Dep. NTIS $4.00.

A study is presented of the noise pollution problem for large power parks proposed for the future. Such parks might have an area of about 75 sq. miles, and a generating capacity up to 48000 MW. A comparative analysis has been done for natural and mechanical-draft wet towers as the major sources of acoustic power. Noise radiation from single isolated towers as well as from a dispersed array of towers has been considered for both types of cooling systems. Major noise attenuation effects considered are due to the atmospheric absorption and A-weighting. Conditions of 60F and 70 percent relative humidity in a still atmosphere have been assumed. (auth)

SITING

4978 (PRNC—185) **Hydrographic data report: south coast of Puerto Rico, 1973—1974.** Wood, E.D.; Asencio, R. (Puerto Rico Nuclear Center, Mayaguez). 15 May 1975. Contract AT(40-1)-1833. 191p. Dep. NTIS $12.75.

4979 (UEC-AEC—740107(Draft)) **Review of underground siting of nuclear power plants.** (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). Jan 1974. Contract AT(11-1)-2226. 159p. Dep. NTIS $11.00.

A review of the potential for the underground siting of nuclear power generating plants has been undertaken. The review comprised a survey and assessment of relevant published documents currently available, together with discussions with Government sponsored agencies and other bodies, to evaluate the current status of technology related to the design and construction of underground nuclear power plants. It includes a review of previous work related to the underground siting of power plants and other facilities; a preliminary evaluation of the relative merits of the various concepts of undergrounding which have been proposed or constructed; a review of current technology as it relates to the requirements for the design, construction and operation of underground nuclear power plants; an examination of the safety and environmental aspects; and the identification of areas of further study which will be required if the underground is to be established as a fully viable alternative to surface siting. No attempt has been made to draw final conclusions at this stage. Nothing has been found to suggest that the underground siting concept could not provide a viable alternative to the surface concept. It is also apparent that no major technological developments are required. It is not clear, however, whether the improvements in safety and containment postulated for the underground can be realized at an economic cost; or even whether any additional cost is in fact involved. The problem is essentially site dependent and requires further study for which recommendations are made. (auth)

RADIOACTIVE EFFLUENTS

4980 **Summary of radioactivity released in effluents from nuclear power plants during 1973.** *Nucl. Saf.*; **16**: No. 6, 734-738(1975).

Releases of radioactivity in airborne and liquid effluents and the number of shipments and activity of solid waste have been compiled by the Nuclear Regulatory Commission from license reports for 1973. The wide variations in the radioactivity releases were due to differences in plant size, power level, fuel performance, and effluent-treatment methods. Data covering specific isotopes of particular interest are summarized. In all cases, releases of radioactivity were only small fractions of permissible limits set by applicable regulations or in technical specifications. (auth)

THERMAL EFFLUENTS

4981 (ANL/WR—75-4) **Field studies of the thermal plume from the D. C. Cook submerged discharge with comparisons to hydraulic-model results.** Frigo, A.A.; Paddock, R.A.; McCown, D.L. (Argonne National Lab., Ill. (USA)). Jun 1975. Contract W-31-109-Eng-38. 35p. Dep. NTIS $4.00.

The Donald C. Cook Nuclear Plant at Bridgman, Michigan, uses submerged-diffuser discharges as a means of disposing waste heat into Lake Michigan. Preliminary results of temperature surveys of the thermal plume at the D. C. Cook Plant are presented. Indications are that the spatial extent of the plume at the surface is much smaller than previous results for surface shoreline discharges, particularly in the near and intermediate portions of the plume. Comparisons of limited prototype data with hydraulic (tank)-model predictions indicate that the model predictions for centerline temperature decay at the surface are too high for the initial 200 m from the discharge, but are generally correct beyond this point to the limits of the model. In addition, the hydraulic-model results underestimate the areal extent of the near and intermediate portions of the plume at the surface. Because this is the first report of a new field program, several inadequacies in the field-measurement techniques are noted and discussed. New techniques that have been developed to remedy these deficiencies, and which will be implemented for future field work, are also described. (auth)

RESEARCH, TEST, EXPERIMENTAL, ZERO-POWER, AND TRAINING REACTORS AND SUBCRITICAL ASSEMBLIES

4982 (ANCR—1170) **Decontamination and decommissioning of the EBR-I complex. Topical report No. 3. NAK disposal pilot plant test.** Commander, J.C.; Lewis, L.; Hammer, R. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Jun 1975. 24p. Dep. NTIS $4.00.

Decontamination and decommissioning of the Experimental Breeder Reactor No. 1 (EBR-I) requires processing of the primary coolant, an eutectic solution of sodium and potassium (NaK), remaining in the EBR-I primary and secondary coolant systems. While developing design criteria for the NaK processing system, reasonable justification was provided for the development of a pilot test plant for field testing some of the process concepts and

proposed hardware. The objective of this activity was to prove the process concept on a low-cost, small-scale test bed. The pilot test plant criteria provided a general description of the test including: the purpose, location, description of test equipment available, waste disposal requirements, and a flow diagram and conceptual equipment layout. The pilot plant test operations procedure provided a detailed step-by-step procedure for operation of the pilot plant to obtain the desired test data and operational experience. It also spelled out the safety precautions to be used by operating personnel, including the requirement for alkali metals training certification, use of protective clothing, availability of fire protection equipment, and caustic handling procedures. The pilot plant test was performed on May 16, 1974. During the test, 32.5 gallons or 240 lb of NaK was successfully converted to caustic by reaction with water in a caustic solution. (auth)

4983 (ANCR—1249) **LOFT voltage insertion calibaration program.** Tillitt, D.N.; Miyasaki, F.S. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Aug 1975. Contract E(10-1)-1375. 129p. Dep. NTIS $5.45.

The Loss-of-Fluid Test (LOFT) Facility is an experimental facility built around a "scaled" version of a large pressurized water reactor (LPWR). Part of this facility is the Data Acquisition and Visual Display System (DAVDS) as defined by the LOFT System Design Document SDD 1.4.2C. The DAVDS has a 702 data channel recording capability of which 548 are recorded digitally. The DAVDS also contains a Voltage Insertion Calibration Subsystem used to inject precise and known voltage steps into the recording systems. The computer program that controls the Voltage Insertion Calibration Subsystem is presented. 7 references. (auth)

4984 (CONF-750984—1) **Experimental and theoretical investigations on the dynamic response of EBR-II ducts under pressure pulse loading.** Chopra, P.S.; Srinivas, S. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 32p. Dep. NTIS $4.75.

From International seminar on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures; Berlin, German, Federal Republic of [9]F.R. Germany[9] (8 Sep 1975).

In order to assess the potential damage to hexagonal subassembly ducts (cans) that may result from rapid gas release from a failed element the EBR-II project has conducted experiments and analyses. Additional experimental and analytical investigations are now being conducted to assure fail-safety of the ducts. Fail-safety is defined as the ability of a duct to withstand pressure pulses from failed elements during all reactor conditions without damage to adjacent ducts or any other problems in fuel handling. The results of 93 EBR-II duct tests conducted primarily by Koenig have been reported previously. The results of empirical correlations of some of these tests to determine the influence of several variables on the pressure pulse experienced by a duct and on the duct deformation are presented. The variables include the type of gas contained in the simulated element (tube), the element and duct materials, the presence or absence of flow restrictors in the element, and the way gas was released. 8 references. (auth)

4985 (CONF-751116—9) **ZPR-9 airborne plutonium monitoring system.** Rusch, G.K.; McDowell, W.P.; Knapp, W.G. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 8p. Dep. NTIS $4.50.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

An airborne plutonium monitoring system which is installed in the ZPR-9 (Zero Power Reactor No. 9) facility at Argonne National Laboratory is described. The design and operational experience are discussed. This monitoring system utilizes particle size and density discrimination, alpha particle energy discrimination, and a background-subtraction techique operating in cascade to separate airborne-plutonium activity from other, naturally occurring, airborne activity. Relatively high sensitivity and reliability are achieved. (auth)

4986 (GEAP—14057) **Preliminary analysis of the cause of failures of experimental mixed oxide fuel rods in EBR-II.** Patel, M.; Murata, R.E. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jul 1975. Contract AT(04-3)-893. 48p. AT.

An analysis of failures recently discovered in experimental encapsulated mixed oxide fuel rods in EBR-II is described. It is concluded that the principal cause of the failures was the fuel-cladding mechanical interaction due to differential thermal expansion during the power increase produced when the radial UO_2 blanket in the reactor was replaced by a stainless steel reflector. Power increases ranging from approximately 23 percent to approximately 135 percent were estimated for the observed failure regions in the rods analyzed. The extent of damage caused by a power change depends on the operating temperature and the magnitude of temperature change. The analysis indicates that for the power changes considered in the analysis, rods operating at high temperatures are liable to fail at the top by thermal creep deformation, while rods operating at lower temperatures are liable to fail at the bottom by plastic deformation. (9 references) (auth)

4987 (GESR—2113) **Thermionic fuel element in-pile test results.** Gilliland, D.L.; Holtslag, D.J.; Samstad, G.I.; Street, G. (General Electric Co., Pleasanton, Calif. (USA). Nuclear Thermionic Power Operation). Nov 1968. Contract AT(04-3)-189. 152p. Dep. NTIS $7.75.

Declassified 20 Oct 1975.

A program of research and development has been directed toward the development of a nuclear thermionic fuel element and a compact thermionic reactor system under AEC Contract AT(04-3)-189, Project Agreement No. 32. A major focus of the program has been on the irradiation of representative 3-cell thermionic fuel elements (TFEs) in the General Electric Test Reactor (GETR). Key materials and TFE components also have been under development through supporting analytical studies, out-of-pile experimentation and fabrication development, through irradiation of single cell in-pile converters (SCIPs) in the GETR, and through post-test examination of irradiated TFEs and SCIPs. This report describes the fabrication, test operation and pertinent post-operational examination results for the five 3-cell, 1-inch TFEs and four SCIPs tested in the period of this status report. (auth)

4988 (HEDL-TME—75-92) **Sodium frost observations in CRCTA: IVHM penetration plug.** Currie, A.J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1975. Contract AT(45-1)-2170. 18p. AT.

Sodium frost formations on the In-Vessel Handling Machine (IVHM) penetration plug are described. This plug, installed in the Composite Reactor Components Test Activity (CRCTA) to close and insulate the IVHM penetration in the absence of the IVHM component, was exposed to sodium vapor for 210 days. During plug residence, the CRCTA sodium pool temperatures ranged between 350°F and 1100°F. Inspection of the plug immediately following removal revealed sodium frost deposited over the entire in-vessel surface. Most of the frost appeared as a fine, grayish-white powder, distributed evenly over the top and bottom one-third sections of the plug. A band of more concentrated frost, deposited in rough beads and drip-patterned configurations, was observed around the plug midsection. Sodium frost was also observed on the CRCTA nozzle flange, deposited in crustlike formations, as well as in the 0-ring grooves in the flange. A detailed comparison of the annular profiles of the CRCTA/IVHM plug and CRCTA/IVHM test component is made, followed by predicted patterns of sodium frost formation on the IVHM test component. Implications for FFTF operations are also discussed. (auth)

4989 (LA—6031-MS) **Conceptual design for a fast reactor safety test facility. Preliminary report.** Allen, J.D.; Cort, G.E.; McLaughlin, T.P.; Palmer, R.G. (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1975. 75p. Dep. NTIS $5.45.

In May 1975 Los Alamos Scientific Laboratory issued a preliminary report on a study of Fast Reactor Safety Test Facilities. The study addressed itself to three closely related tasks. (1) A review of the current understanding of fast reactor safety with the aim of identifying important areas of uncertainty which cannot be adequately resolved using analysis, out of pile and/or existing in-pile facilities. (2) Conceptual design studies of one or more new in-pile facilities having characteristics identified in (1) above. (3) An examination of advanced data acquisition techniques for possible incorporation in the new facilities. The work reported is an extension of the earlier work in task area (2) above. Based largely on conclusions drawn from the earlier work the scope of the current effort has been narrowed to the design study of a Type A facility operating in the Class III mode, i.e., a facility capable of accommodating up to 37 test pins and capable of imposing a burst on top of a high steady state power level. (auth)

4990 (ORNL-TM—5009) **Bulk shielding facility quarterly report, January, February, and March of 1975.** Hurt, S.S. III; Lance, E.D.; Thomas, J.R. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 25p. Dep. NTIS $4.00.

The BSR operated at an average power level of 1,942 kw for 66.95 percent of the time during January, February, and March. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. The BSR was operated at low and variable power during this quarter for 36.190 hours as part of the training programs for Tennessee Valley Authority (TVA) personnel from Sequoyah. The PCA was also used in the above-mentioned training program and was operated on twenty-six occasions when nuclear engineering students from the University

of Oklahoma, the University of Tennessee, and TVA personnel actively participated in training laboratories. (auth)

4991 (ORNL-TM—5055) **HFIR instrumentation error analysis.** Roberts, M.J. (Oak Ridge National Lab., Tenn. (USA)). Dec 1975. Contract W-7405-eng-26. 31p. Dep. NTIS $5.00.

The accuracies of the measurements of operating conditions made by the electronic safety system at the High Flux Isotope Reactor were calculated theoretically. The technique was small-signal sensitivity analysis of the errors as they accumulated through cascaded instruments in various systems. The error bounds (for 99.7 percent probability) at typical operation of 100 MW thermal power (mode 1) were approximately 4.05 MW in heat power, 1.82°F in inlet temperature, and 5.95 MW in perceived heat power on flux-to-flow ratio. The error bound in flow at the nominal flow trip point of 1500 gpm was approximately 86 gpm. The maximum unfavorable error in perceived heat power in flux-to-flow measurement was +420 kW for operation in research mode 2 (lower coolant flow and, hence, lower power; and approximately the same temperature difference as in mode 1), and +17.1 kW for mode 3 (no coolant flow, static operation, and, hence, low power). (auth)

4992 (UCRL—51906) **Neutron radiographic facility at the 3-mw Livermore pool-type reactor.** Richards, W.J.; Peterson, R.T.; Prindle, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Sep 1975. Contract W-7405-Eng-48. 33p. Dep. NTIS $4.00.

A description is presented of the neutron experimental radiographic facility at the Livermore Pool-Type Reactor. This facility was installed in 1974 to assist Lawrence Livermore Laboratory research programs. Some of the testing techniques used to modify the neutron beam and the present radiographic parameters are also discussed. (auth)

PLUTONIUM AND ISOTOPE PRODUCTION, CHEMONUCLEAR, MATERIALS TESTING, AND MATERIALS PROCESSING REACTORS

4993 (UNI—351) **N Reactor 1974 Steam Generator Operating Experience.** Kratzer, W.K. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 14 Mar 1975. Contract AT(45-1)-1857. 4p. Dep. NTIS $4.00.

REACTOR SAFETY

4994 (ANCR—1163) **Experiment DTA report for semiscale transparent vessel countercurrent flow tests.** Hanson, D.J. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Oct 1975. Contract E(10-1)-1375. 231p. Dep. NTIS $7.60.

Steady state air-water tests were performed as part of the Semiscale Blowdown and Emergency Core Cooling (ECC) Project to investigate downcomer countercurrent flow and downcomer bypass flow phenomena. These tests were performed in a plexiglass representation of the Semiscale pressure vessel which allowed changes to be madein the geometry of the upper annulus and downcomer for the purpose of investigating the sensitivity of downcomer and bypass flow to changes in system geometry. Tests were also performed to investigate the effects of two-phase inlet flows and different initial system pressures on countercurrent and bypass flow. Results for each test are presented in the form of computer printout of the measurements and of a summary of the pertinent calculated flow rates, pressures, and dimensionless volumetric fluxes. Descriptions of the test facility, instrumentation, operating procedures, and test conditions are also presented. An error analysis is presented for selected volumetric flux calculations. 10 references. (auth)

4995 (ANCR—1228) **Thermal-hydraulic response of the semiscale Mod-1 system: isothermal test series.** Cartmill, C.E. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Oct 1975. Contract E(10-1)-1375. 78p. Dep. NTIS $5.45.

Selected experimental thermal-hydraulic data from the recent isothermal blowdown test series performed in the Semiscale Mod-1 geometry are analyzed from an experimental viewpoint with emphasis on explaining differences between the data and expected results. Comparisons are made between the trends measured by the system instrumentation and the trends predicted by analytical tools, including the RELAP4 computer code, to aid in understanding the interactions between phenomena occurring in different parts of the system. The analyses presented are valuable for evaluating the adequacy and improving the predictive capability of analytical models developed to predict the system of a pressurized water reactor during a postulated loss-of-coolant accident (LOCA). 20 references. (auth)

4996 (ANCR—1254) **Quarterly technical report on water reactor safety programs sponsored by the Nuclear Regulatory Commission's Division of Reactor Safety Research, January—March 1975.** (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Sep 1975. Contract E(10-1)-1375. 155p. Dep. NTIS $7.60.

4997 (BMI-X—665) **HAARM-2 users manual. Task 56.** Reed, L.D.; Gieseke, J.A. (Battelle Columbus Labs., Ohio (USA)). 31 Oct 1975. Contract W-7405-eng-92. 72p. Dep. NTIS $5.45.

A computer code for analyzing aerosol behavior within LMFBR containment during postulated accidents is described. The code allows time dependence of containment gas pressure and temperature as well as wall temperature gradients. (JMR)

4998 (BNL—20583) **Steam generator and circulator model for the HELAP code.** Ludewig, H. (Brookhaven National Lab., Upton, N.Y. (USA)). Jul 1975. 31p. Dep. NTIS $4.00.

An outline is presented of the work carried out in the 1974 fiscal year on the GCFBR safety research project consisting of the development of improved steam generator and circulator (steam turbine driven helium compressor) models which will eventually be inserted in the HELAP (1) code. Furthermore, a code was developed which will be used to generate steady state input for the primary and secondary sides of the steam generator. The following conclusions and suggestions for further work are made: (1) The steam-generator and circulator model are consistent with the volume and junction layout used in HELAP, (2) with minor changes these models, when incorporated in HELAP, could be used to simulate a direct cycle plant, (3) an explicit control valve model is still to be developed and would be very desirable to control the flow to the turbine during a transient (initially this flow will be controlled by using the existing check valve model); (4) the friction factor in the laminar flow region is computed inaccurately, this might cause significant errors in loss-of-flow accidents; and (5) it is felt that HELAP will still use a large amount of computer time and will thus be limited to design basis accidents without scram or loss of flow transients with and without scram. Finally it may also be used as a test bed for the development of prototype component models which would be incorporated in a more sophisticated system code, developed specifically for GCFBR's. (auth)

4999 (CENPD—63(Rev.1)) **1/5 scale intact loop post-LOCA steam relief tests.** Brodrick, J.R.; Burchill, W.E.; Lowe, P.A. (Combustion Engineering, Inc., Windsor, Conn. (USA). Nuclear Power Dept.). Mar 1973. 243p. Dep. NTIS $9.00.

The test program and experimental results for steam and emergency core cooling water interaction in the intact cold leg piping of a model of a pressurized water reactor are described. The program background and objectives are presented. The test apparatus and testing technique are discussed. Raw data and reduced data are presented in detail. (auth)

5000 (CONF-750966—1) **Analysis of LMFBR primary system response to an HCDA using an Eulerian computer code.** Chang, Y.W.; Wang, C.Y.; Chu, H.Y.; Abdel-Moneim, M.T.; Gvildys, J. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 35p. Dep. NTIS $4.75.

From International conference on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures; West Berlin, F.R. Germany (8 Sep 1975).

Applications of an Eulerian code to predict the response of LMFBR containment and primary piping systems to hypothetical core disruptive accidents (HCDA), and to analyze sodium spillage problems, are described. The computer code is an expanded version of the ICECO code. Sample problems are presented for slug impact and sodium spillage, dynamics of the HCDA bubbles, and response of a piping loop. (JWR)

5001 (CONF-750966—2) **LMFBR subassembly response to local pressure loadings: an experimental approach.** Marciniak, T.J.; Ash, J.E.; Marchertas, A.H.; Cagliostro, D.J. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 34p. Dep. NTIS $4.75.

From International conference on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures; West Berlin, F.R. Germany (8 Sep 1975).

An experimental program to determine the response of LMFBR-type subassemblies to local subassembly accidents caused by pressure loadings is described. Some results are presented and compared with computer calculations. (JWR)

5002 (CONF-751013—9) **Implicit Eulerian method for analyzing transient phenomena in fast reactors.** Wang, C.Y. (Argonne National Lab., Ill. (USA)). Oct 1975. Contract W-31-109-Eng-38. 12p. Dep. NTIS $4.00.

From 12. annual meeting of the Society of Engineering Science; Austin, Texas, USA (21 Oct 1975).

For Univ. of Texas, Austin.

An Eulerian compressible hydrodynamic method is presented for analyzing transient phenomena in nuclear reactors following hypothetical excursions. The method uses the implicit integration scheme to solve nonlinear equations of fluid dynamics in conjunction with a thin-shell analysis to calculate the response of the wall boundary. Detailed formulations are given. Results are presented for two example problems and compared with available experimental data. 6 references. (auth)

5003 (COO—2152-18) **Two phase pressure drop across abrupt area changes in oscillatory flow.** Weisman, J.; Ake, T.; Knott, R. (Cincinnati Univ., Ohio (USA)). May 1975. 80p. Dep. NTIS $5.45.

The ability of one-dimensional momentum balances to predict behavior during two-phase oscillatory flow has been examined. Flow oscillations in a Freon-Freon vapor system were induced by cycling a three-way valve so as to divert a varying portion of the total flow from the test section. The data taken included the phase shift between pressure and flow curves and the head fluctuation to flow fluctuation ratio. These data were compared to theoretical predictions. For void fractions below about 0.55, reasonable agreement between predictions and observations was obtained. At the highest void fractions examined, agreement between prediction and measurement was poor. However, at these high void fractions measurement errors may have been very substantial. Further, the simplifying assumptions required by the numerical calculation procedure chosen could no longer be considered valid. No real conclusion could therefore be drawn from the data at high voids. (auth)

5004 (GEAP—14053) **Review of sodium fire analytical models.** Sarma, B.U.B.; Thompson, R.C.; Stitt, R.K. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Jun 1975. 107p. AT.

A review of the available computer codes: SPRAY, SOFIRE II and CACECO was performed. These codes were utilized for analyzing sodium fires and modeling several sodium fire experiments conducted by Atomics International (AI). These results were inter-compared to evaluate the codes. Within a limited range of spray fires in low oxygen environments, the SPRAY code appears to yield reasonable results. It was found that CACECO is a large, multi-cell, multi-purpose code and inexpensive to use. Coding was implemented to facilitate extensive and detailed modeling of several simultaneous effects. A significant limitation of this code is its inability to model characteristics of spray fires and associated droplet combustion. SOFIRE II has been used to analyze pool fires in low oxygen and air environments. Satisfactory results could not be obtained at this time in the attempts to model the pool fire experiments. However, previously published reports (by AI) have shown the SOFIRE II calculations to compare favorably with the experiments. With careful application and using the SPRAY, SOFIRE II, and CACECO codes in conjunction with each other, primary sodium fires in inerted environment (less than or equal to 2 vol percent oxygen) can be adequately analyzed to obtain satisfactory results. In contrast, there is a significant deficiency, as there is no code available for analyzing spray fires in air environment. At the present time, at best, only most conservative and simplified calculations can be performed for analyzing spray fires in air. On-going analytical and experimental programs should provide the necessary support so as to eliminate the undue conservatism that is being applied for the sodium fire analyses at the present time. (auth)

5005 (GEAP—14055) **Radiological source-term models for LMFBR hypothetical core disruptive accidents.** McDonald, J.W.; Cantrell, R.T.; Garrity, W.E.; Kriebel, A.R.; Stitt, R.K.; Teresi, J.D. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jul 1975. Contract AT(04-3)-893. 108p. AT.

Generic models to analyze and evaluate radiological sources postulated to occur in hypothetical core disruptive accidents are developed. Activity during the first year was directed primarily to reviewing and evaluating state-of-the-art models used in radiological assessment analyses. The transport of radionuclides from the reactor core to regions surrounding the reactor vessel is divided into four phases: (1) disruption of the core and radionuclide release, (2) rapid discharge of radiological mixture from the core, (3) buoyant transport of radiological mixture to cover space, and (4) release of radionuclides from the reactor vessel. In addition, it is hypothesized that there may be a post-accident release of radionuclides as a result of the core melting through the reactor vessel. (73 references) (auth)

5006 (HEDL-SA—771) **Fuel pin transient behavior technology applied to safety analyses. Pesentation to AEC Regulatory Staff 4th Regulatory Briefing on safety technology, Washington, D.C., November 19—20, 1974.** (Hanford Engineering Development Lab., Richland, Wash. (USA)). Nov 1974. 301p. (CONF-741174—). Dep. NTIS $18.25.

From 4. regulatory briefing on safety technology; Washington, District of Columbia, USA (19 Nov 1974).

Information is presented concerning LMFBR fuel pin performance requirements and evaluation; fuels behavior codes with safety interfaces; performance evaluations; ex-reactor materials and simulation tests; models for fuel pin failure; and summary of continuing fuels technology tasks. (DCC)

5007 (HEDL-TC—372) **Justification for position that low level earthquakes (less than or equal to 0.05g) result in negligible degradation in lifetime of FFTF equipment.** Severud, L.K.; Metzger, F.S.; Weiner, E.O. (comps.). (Hanford Engineering Development Lab., Richland, Wash. (USA)). 3 Jun 1975. Contract E(45-1)-2170. 26p. AT.

An evaluation was performed to show that the degradation of FFTF equipment lifetime due to creep and fatigue damage caused by three 0.05g earthquakes with six maximum stress cycles each would be negligible. The results of the study are presented. (JWR)

5008 (HEDL-TME—75-40) **Evaluation of FFTF fuel pin transient design procedure.** Baars, R.E. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. Contract AT(45-1)-2170. vp. AT.

Data from Fuel Cladding Transient Test (FCTT) experiments and ANL loss-of-flow tests conducted in the TREAT facility are compared with fuel pin cladding burst pressures calculated using FFTF fuel pin transient operation design analysis procedures. The comparison is made for specimens irradiated in EBR-II to exposures of 30,000, 40,000 and 50,000 MWd/MTM, and for unirradiated specimens. Fuel pin response to unterminated rapid reactivity insertion events was also analyzed during the FFTF Plant Protective System (PPS) design. The conservatism of this analysis was demonstrated by predicting the time of fuel pin failure for several TREAT-simulated unterminated transient overpower tests with the design analysis procedure and comparing these predictions with the observed failure times. The principal conclusions from the evaluation are: The design procedure predicts conservative burst pressures for integral fuel pin cladding exposed in EBR-II up to 50,000 MWd/MTM. Coupled with the conservative design fission gas release assumption of 100 percent, it was further concluded that the FFTF fuel pin cladding integrity limit (defined as the temperature at which the design burst pressure equals the plenum pressure) is conservative to an exposure of at least 50,000 MWd/MTM. The design procedure predicts conservative (early) fuel pin failure times for rapid reactivity insertion events and the PPS response requirements based on the design procedure are conservative. (auth)

5009 (LA—6054PR) **HTGR safety research program. Progress report, April—June 1975.** Kirk, W.L. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. Contract W-7405-ENG-36. 55p. Dep. NTIS $5.45.

Progress in HTGR safety research is reported under the following headings: fission product technology; primary coolant impurities; structural investigation; safety instrumentation and control systems; phenomena modeling and systems analysis. (JWR)

5010 (NUREG—75/090) **Report to the Congress on abnormal occurrences, January—June 1975.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Oct 1975. 35p. NTIS $3.75.

During the first half of 1975, no incidents or events occurred at the 53 licensed operating nuclear power plants which had an actual impact on or consequence to the health and safety of the public. However, although an adequate margin of safety was always present, some events did occur which involved a temporary but significant reduction in the level of protection. These three single, one recurring and three generic significant events were considered to be abnormal occurrences, and are reviewed in this report. The occurrence of these events has shown that the reliance on the defense-in-depth concept is sound for the protection of public health and safety. Although the reported events took place within the first six months of 1975, the descriptions, causes, and actions taken to prevent recurrence are reported based on status as of July 31, 1975. (auth)

5011 (ORNL—5050, pp 86-90) **Reactor safety research.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

Reactor-safety related research included studies of fission product release from LWR fuel and transient release from LMFBR fuel. (JWR)

5012 (ORNL—5050, pp 91-92) **Nuclear Regulatory Commission programs.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

Programs conducted for the US NRC included development of "as low as practicable" guides for the nuclear fuel cycle, safety review of nuclear facilities, and safety review of transport casks. (JWR)

5013 (ORNL-TM—5062) **HTGR safety studies quarterly progress report for the period ending December 31, 1974, for the Gas-Cooled Reactors Branch, Directorate of Licensing.** Sanders, J.P. Sr. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 22p. Dep. NTIS $4.00.

A thermal analysis for a Loss of Forced Circulation (LOFC) accident using a 2-dimensional model of the 2000-MW(t) Summit Station core was performed. Evaluation of modifications to the Preliminary Safety Analysis Report (PSAR) for both the Fulton and the Summit Stations concerning the performance of the Core Auxiliary Heat Exchanger (CAHE) has been made. Analysis of the stress in the metal cover plates for the insulation on the PCRV liner under normal operating and accident conditions has continued. Work has continued on the general development of computation methods for use in the determination of thermal conditions in the core and in the major components of the primary circuit during abnormal conditions. (auth)

5014 (ORNL-TM—5085) **Monthly progress report for the HTGR safety studies for the Division of Technical Review, U.S. Nuclear Regulatory Commission.** (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. 7p. Dep. NTIS $4.00.

5015 (ORNL-TM—5120) **HTGR safety studies quarterly progress report for the period ending June 30, 1975 for the Gas-Cooled Reactor Branch, Division of Reactor Licensing.** Sanders, J.P. Sr. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 17p. Dep. NTIS $4.00.

Work being performed for the Gas-Cooled Reactors Branch (GCRB) of the Division of Reactor Licensing (DRL) for their use in the evaluation of HTGR system response under abnormal conditions is reported. A major effort during this quarter has been the evaluation of the temperature in the Fort St. Vrain system following a design base depressurization accident (DBDA) with two of the circulators operating at 7000 rpm. (auth)

5016 (ORNL-TM—5128) **Quarterly progress report on high-temperature gas-cooled reactor safety studies sponsored by the NRC Division of Reactor Safety Research for July—September 1975.** Sanders, J.P. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 125p. Dep. NTIS $4.00.

Progress is reported on HTGR systems and safety analyses and computer code implementation. (JWR)

5017 (ORNL-TM—5131) **Monthly highlights for office of Nuclear Regulatory Research programs at Oak Ridge National Laboratory.** Fee, G.G. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 33p. Dep. NTIS $4.00.

Brief summaries of reactor-safety-related research conducted for the US NRC are presented. (JWR)

5018 (UCLA-ENG—7582) **Preliminary assessments of carbide fuel pins during mild overpower transients.** Nickerson, G.M. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). Oct 1975. Contract AT(04-3)-34. 78p. Nuclear Regulatory Commission, Washington, DC.

Thesis.

The work presented deals with safety considerations for Liquid Metal Fast Breeder Reactors fueled with mixed carbides. Beginning with a literature survey that reviews a variety of topics germane to carbide fuel development and safety research, general characteristics concerning this advanced fuel are presented. Further, an evaluation of the future needs for experimental and analytical research efforts is presented. A preliminary investigation of the unprotected transient overpower accident sequence postulated for a large carbide fueled reactor is also presented. The HOPE computer code is the computational tool used to analyze a conceptual core design fueled with mixed carbides of uranium and plutonium. The details of this design are presented and compared with those of the Clinch River Breeder Reactor Plant. Results of HOPE calculations for both helium and sodium bonded carbide fueled cores are presented and compared with a similar study performed on an oxide core. Conclusions are drawn based on the findings of the preliminary transient overpower studies conducted. Recommendations are made where HOPE code improvements are needed. (auth)

5019 **EPRI water-reactor safety program.** Loewenstein, W.B. (Electric Power Research Inst., Palo Alto, CA). *Nucl. Saf.*; **16**: No. 6, 659-666(1975).

The rationale, structure, and current status of the Electric Power Research Institute (EPRI) Water-Reactor Safety Program are summarized. The efforts emphasize quantified assurance of safety, usually based on the synthesis of pertinent experimental, analytical, and calculational results. The scope of the program ranges from the quantified definition of the course of the postulated loss-of-coolant accident to continuing routine monitoring of the pressure boundary. This includes research on such diverse efforts as two-phase flow behavior in complex geometries, interaction of potential tornado-generated missiles with reinforced-concrete structures, aspects of probabilistic safety appraisal, and techniques to quantify the diagnosis of the performance of the pressure boundary. The EPRI program efforts are coordinated with the needs of the utility industry through several advisory committees. The program is coordinated with the programs of national sponsoring agencies and maintains liaison with reactor vendors and architect-engineers. Program segments are implemented by reactor vendors, architect-engineers, consulting organizations, national laboratories, independent research organizations, and universities. In addition to coordination with national agencies, arrangements for cooperation and exchange have been initiated with several foreign national and utility organizations. (auth)

5020 **Fragmentation modeling relative to the breakup of molten UO_2 in sodium.** Cronenberg, A.W.; Grolmes, M.A. *Nucl. Saf.*; **16**: No. 6, 688-700(1975).

An important aspect of the fuel-coolant interaction problem relative to liquid-metal-cooled fast breeder reactor safety analysis is the fragmentation of molten oxide fuel on contact with liquid-sodium coolant. A proper description of the kinetics of such an event requires an understanding of the breakup process and an estimate of the size and dispersion of such finely divided fuel in the coolant. In recent years, considerable interest has centered on the problem of determining the nature of the fragmentation process. This article reviews both analytic and experimental studies pertaining to such breakup in light of recent developments in the understanding of heat-transfer and solidification phenomena during quenching of UO_2 in sodium. Where possible, an attempt is made to assess the work potential for fragmentation of the various proposed models and to compare the predicted particle size with experimental results. (auth)

5021 **REVISION AND ADDENDUM TO NUCLEAR SAFETY CRITERIA FOR THE DESIGN OF STATIONARY PRESSURIZED WATER REACTOR PLANTS.** Hinsdale, IL; United States of America (USA); American Nuclear Society (1975). 5p. (ANSI—N18.2a-1975). $5.50.

A standard for containment and component safety classifications for PWR type reactors is presented. (JWR)

ENERGY STORAGE

5022 **Economic incentive for introducing electric storage devices into the national energy system.** Braun, C.; Cherniavsky, E.A.; Salzano, F.J. (Brookhaven National Lab., Upton, NY). pp 82-90 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The allowed capital costs for the introduction of electric storage devices into the national energy system are examined, utilizing the Brookhaven Energy System Optimization Model (BESOM). The storage devices are characterized by their overall electric-to-electric conversion efficiencies, which are varied parametrically over the entire range of feasible efficiencies. Electric storage devices are considered as peaking plants, operating at load factors of 0.5, 0.10, and 0.20. The possible introduction of electric storage plants to both intermediate and peaking load generation, when operating on a weekly instead of a daily cycle, is also considered. The capital costs at which these devices become economically attractive are calculated using the marginal values obtained from the linear programming problem solution. The break-even capital costs (which include capitalized operaton and maintenance expenditures) are computed as a function of the conversion efficiencies for various distillate fuel oil prices. Higher break-even capital costs are found at all conversion efficiencies for electric storage plants designed to supply peak load demands only, than for storage devices operating at the intermediate plus peaking

mode. This pattern is attributed to the fact that storage plants supplying intermediate plus peaking loads have to operate on a weekly cycle (large energy storage capacity), and compete against relatively cheap intermediate load plants, including HTGR's. Storage devices supplying peak load demands can operate on a daily cycle, and compete with expensive gas turbines for peaking applications. (auth)

FLYWHEELS

5023 (UCRL—76891) **Fiber composites for energy storage flywheels.** Penn, L.; Chiao, T.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Oct 1975. Contract W-7405-Eng-48. 21p. (CONF-760201—1). Dep. NTIS $4.50.

From 31. annual conference of the Society of the Plastics Industry; Washington, District of Columbia, USA (3 Feb 1976).

The flywheel is an intrinsically efficient storage system. When made of high strength-to-weight fiber composites, it can be a portable, safe, and economically feasible means of supplying energy. The potential applications, existing materials studies, and current activities in fiber composite flywheel research are reviewed, work with fiber composites is reported. (auth)

5024 (UCRL—77486) **Ideas and experiments in magnetic interfacing.** Aaland, K.; Lane, J.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Dec 1975. Contract W-7405-Eng-48. 10p. (CONF-751133—6). Dep. NTIS $3.50.

From Proceedings of fly wheel technology; Berkeley, California, USA (10 Nov 1975).

Simulated experiments on a small scale have begun as a result of developing magnetomechanical devices. Rim-only wheels for automobiles are envisioned, with energy coming from two counter-revolving rim-only flywheels. The proposition that magnetic bearings can only be stable by active feedback is questioned (auth)

5025 (UCRL—77543) **Epoxy resins for flywheel applications.** Rinde, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Dec 1975. Contract W-7505-Eng-48. 6p. (CONF-751133—2). Dep. NTIS $4.50.

From Proceedings of fly wheel technology; Berkeley, California, USA (10 Nov 1975).

Key properties of three epoxy resin systems of different characteristics were found to be suitable for filament winding and useful for flywheel applications. (auth)

5026 (UCRL—77567) **LLL program for composite flywheel.** Chiao, T.T.; Stone, R.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Dec 1975. 3p. (CONF-751133—4). Dep. NTIS $3.50.

From Proceedings of fly wheel technology; Berkeley, California, USA (10 Nov 1975).

The Lawrence Livermore Laboratory has mapped out a flywheel development program intended to (1) provide a data base for engineering design, (2) solve some long-standing problems of composites and (3) develop flywheel manufacturing processes. Information generated will be disseminated promptly to industry. Studies of composites will characterize fiber-resin matrices, measure their static engineering properties, including those that are time-dependent, examine failure criteria, reliability and fatigue resistance and study hybrid fiber resin constructions. Model flywheels will be built and techniques for their mass production will be evaluated. (auth)

5027 (UCRL—77568) **Engineering design data for composite materials.** Clements, L.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Dec 1975. Contract W-7405-Eng-48. 5p. (CONF-751133—5). Dep. NTIS $3.50.

From Proceedings of fly wheel technology; Berkeley, California, USA (10 Nov 1975).

LLL has been studying some basic mechanical properties of filament-wound composites for use in construction of flywheels. These include elastic and ultimate properties in tension and compression for both longitudinal and transverse modes as well as +-45°-tensile shear properties. Measurements of the properties of composites of Kevlar 49 in an epoxy matrix are complete and are reported, along with limited comparative data from Kevlar 49 in a second epoxy matrix. Some preliminary data from measurements of E-glass/epoxy specimens are also included. (auth)

5028 (UCRL—77569) **Fiber evaluation for flywheel applications.** Penn, L.; Chiao, T.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Dec 1975. Contract W-7405-Eng-48. 2p. (CONF-751133—3). Dep. NTIS $3.50.

From Proceedings of fly wheel technology; Berkeley, California, USA (10 Nov 1975).

Initial results of tensile tests of two kinds of epoxy-coated glass fibers and an epoxy-coated Kevlar 29 aromatic polyamide fiber are reported. Data show that fiber strengths depend directly on resin content. (auth)

BATTERIES

5029 **Battery energy storage for utility load leveling and electric vehicles: a review of advanced secondary batteries.** Yao, N.P. (Argonne National Lab., IL); Birk, J.R. pp 1107-1119 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Advanced secondary batteries that are under development in the U.S. for application to utility load-leveling and electric-vehicle propulsion are reviewed. Of the battery systems being developed, major efforts are presently concentrated on the following four systems: Li/LiCl—KCl/metal sulfide, Na/B—Al_2O_3/S, Zn/aq . $ZnCl_2/Cl_2$, and Zn/aq . KOH/β—NiOOH. In the past few years, because of interest and available financial backing, significant progress has been made in developing each of these systems, and the probability of meeting the technical requirements for the intended applications within the next several years appears good. (auth)

DESIGN AND DEVELOPMENT

5030 (ANL—8057) **High-performance batteries for off-peak energy storage. Progress report, July—December 1973.** Nelson, P.A.; Walsh, W.J.; Steunenberg, R.K.; Battles, J.E.; Shimotake, H.; Yao, N.P.; Tsai, H.C.; Martin, A.E.; Vissers, D.R.; Birk, J.R.; Myles, K.M.; Tuohig, W.D.; Webster, D.S.; Burris, L. (Argonne National Lab., Ill. (USA)). Nov 1974. Contract W-31-109-eng-38. 43p. Dep. NTIS $5.45.

This is the second in a series of semiannual reports on a program at Argonne National Laboratory to develop high-specific-energy lithium/sulfur batteries for off-peak energy storage in electric utility networks. The program was recently expanded to incude the development of lithium/sulfur batteries for electric-vehicle propulsion. The battery designs for the two applications will differ considerably, particularly in cell configuration and electrode design, because of the differing performance requirements. The cells presently being developed have negative electrodes of solid lithium--aluminum alloy, positive electrodes of iron sulfide (FeS_2 or FeS), with an electrolyte of molten LiCl--KCl eutectic (mp, 352°C). The operating temperature of the cells is about 400°C. An engineering-scale (13-cm-dia) cell was operated for 1390 hr and has attained a specific energy of 121 W-hr/kg. The use of iron sulfide positive electrodes has greatly extended the capacity retention and cycle life of the cells. The major areas of experimental work in the program are design and scale-up of individual sealed cells, development of electrodes, testing of materials of construction and fabrication of cell components, and supporting laboratory studies. (21 figures, 8 tables) (auth)

5031 **Long-life low-voltage power thermal battery.** Baldwin, A.R. (Sandia Labs., Albuquerque, NM). *Power Sources Symp., Proc.;* **26**: 137-141(1974).

The electrically activated 2748 is a reserve battery providing 4.5 A at 28 V. The design, development, production, and performance of this battery are described. Applications for less than 60 min are feasible. (RWR)

5032 **Thermal battery for artillery.** Grothaus, K.R. (Sandia Lab., Albuquerque, NM). *Power Sources Symp., Proc.;* **26**: 141-144(1974).

The capabilities of the Ca/LiCl—KCl/$CaCrO_4$/Fe system were determined. Control of molten salt leakage was evaluated. Operation at spins of up to 300 revolutions per sec could be achieved, but only at limited currents. (RWR)

5033 **Battery design and cell testing for electric-vehicle propulsion.** Schertz, W.W.; Chilenskas, A.A.; Kolba, V.M. (Argonne National Lab., IL). pp 634-641 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Batteries for electric vehicle propulsion being developed at ANL employ cells with negative electrodes of solid Li—Al alloy and positive electrodes of FeS or FeS_2; the use of a molten salt electrolyte (LiCl—KCl) requires a cell operating temperature of

400 to 450°C. A preliminary design and layout for a battery with a nominal 42 kW-hr output is given. The battery is based on a cell having a cylindrical multiplate configuration. Each multiplate cell contains three positive and four negative plates, weighs 2.34 kg, delivers 334 W-hr and 203 W/kg peak power, and is sealed within a housing of iron or mild steel. Battery performance curves were calculated from the voltage—current data of a laboratory-scale Li—Al/FeS cell. Experimental tests are also reported for Li—Al/FeS_2 and Li—Al/FeS cells under conditions chosen to simulate use in electric vehicles. (RWR)

5034 **Thermal battery.** Bush, D.M.; Nissen, D.A. (to Energy Research and Development Administration). US Patent 3,898,101. 5 Aug 1975. Filed date 30 May 1974. 5p.

Without significant modification to present battery arrangements, this battery has minimal formation of molten materials about the cell edges. It includes an electrically conductive heat-generating disk in each cell, a Ca anode coated with $Ca(OH)_2$ on the surface adjacent to the disk, and a depolarizer—binder—electrolyte pellet. (RWR)

5035 **Thermal battery.** Bush, D.M.; Nissen, D.A. (to U.S. Energy Research and Development Administration). US Patent 3,898,101. 5 Aug 1975. Filed date 30 May 1974. 6p.

PAT-APPL-474,555.

An improved thermal battery and method for making it are described. This battery includes an electrically conductive heat generating disc positioned within each electrochemical cell, a calcium anode, a depolarizer—binder—electrolyte (DEB) mixture pellet, and a calcium hydroxide coating on the anode. 3 figures. (auth)

MATERIALS, COMPONENTS, AND AUXILIARIES

5036 **Results of thermal battery cell testing.** Bush, D.M. (Sandia Labs., Albuquerque, NM). *Power Sources Symp., Proc.;* 26: 144-147(1974).

A single-cell tester which eliminates some of the usual variables in thermal battery discharge is described. Results applicable to thermal battery design were obtained faster and more cheaply than with battery tests. (RWR)

5037 **Development of high-performance iron sulfide electrodes with porous current collector structures.** Gay, E.C.; Martino, F.J.; Tomczuk, Z. (Argonne National Lab., IL). pp 627-633 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Efforts at ANL to develop iron sulfide electrodes for lithium—aluminum/iron sulfide batteries for off-peak energy storage and electric vehicle propulsion are described. Investigations were conducted to determine the effects on electrode performance of electrode thickness, area, shape, and orientation, as well as composition of the sulfide. Electrodes containing CoS_2 as an additive provided higher performance than those without additive. The electrodes show promise of meeting performance goals. (RWR)

5038 **Cathode for a secondary electrochemical cell.** Gay, E.C.; Martino, F.J. (to U.S. Energy Research and Development Administration). US Patent 3,907,589. 23 Sep 1975. Filed date 18 Jan 1974. 10p.

PAT-APPL-434,459.

An electrochemical cell which comprises an alkali metal anode, a molten salt eutectic including that alkali metal in ionic form, and an improved cathode is described. The cathode composition comprises a transition metal sulfide such as FeS_2, a particulate current collector, e.g., carbon black, electrolyte and a sulfide product, e.g., Li_2S, of the cell reaction in excess of that produced by electrochemical reaction of the transition metal sulfide with the alkali metal in the discharge of the cell. Operation of the cell is performed by first electrocharging the cathode in series with the anode to convert the sulfide reaction product into a usable cathode reactant submerged in molten electrolyte. 5 figures. (auth)

ENERGY MANAGEMENT AND CONSERVATION POLICY

5039 (TID—26900) **Energy in perspective.** Hill, J.H.; Huffman, F.C. (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Oak Ridge Operations Office). 1975. 26p. Dep. NTIS $5.00.

Before the Society of Sigma Xi, State University College, Fredonia, New York, May 13, 1975.

Increasing energy requirements are based on increasing populations and in the U.S., with a fourfold population increase since 1900, total energy consumption has increased fourteen fold. World data for energy per capita consumption, 1968, vs gross national product per capita are graphically compared. Energy sources and their end uses in the U.S. are summarized. Most energy sources for the future require technological development or demonstration to be considered for large blocks of power. The fast breeder reactor, solar energy, oil shales, liquefaction and gasification of coal, fusion reactors, hydrogen, geothermal energy, oil from tar sands, combustion and gasification of waste, superconducting solenoids, flywheels, the wind, the ocean tides, and thermal gradients in the oceans or large lakes are potential energy sources cited. The environmental impact from the winning and use of energy sources is described and may be mitigated through conservation. Improved efficiency in automobile fuel consumption and the use of fuel cells and MHD in converting energy resources are cited as energy conserving measures. In sum, conservation and improved efficiency of energy use, in addition to relieving environmental problems, would lessen the impact of the energy industry on the U.S. economy. (MCW)

CONSERVATION

5040 (BNL—20566) **Conservation as a major alternative.** Hoffman, K.C. (Brookhaven National Lab., Upton, N.Y. (USA)). Oct 1975. 13p. (CONF-751055—2). Dep. NTIS $4.50.

From AIF workshop on the nuclear debate) basic issues for 1976; Boston, Massachusetts, USA (29 Oct 1975).

Conservation is frequently viewed as an alternative to specific energy supply options such as nuclear power. In reality conservation is a clear alternative only to the wasteful use of energy. It must and will come naturally in response to higher energy prices and to a concerted effort to reduce our consumption of scarce resources such as oil and gas. Although it is not really a direct alternative to nuclear power, a strong conservation movement may reduce the level to which any specific supply options must be developed at a given future point in time. There are several important components to a conservation strategy, each of which may have different effects on the level of base load electric capacity, the prime market for nuclear power; these components are: (1) conservation of all energy forms; (2) conservation of scarce energy resources (oil and gas); and (3) conservation of power in the electric sector (by increasing the system load factor). With a general reduction of energy demands from all sources, it is clear that less reliance need by placed on specific sources such as nuclear. There are also strong incentives, however, to place special emphasis on the conservation of scarce resources and on the improvement of electric load factors to conserve power. In these instances, there is an increased need for base-load electric generating facilities. While there is no doubt that a strong conservation effort is necessary, there are uncertainties in choosing an appropriate mix of energy sources to satisfy even the reduced level of energy demands that we hope to achieve in an efficient and environmentally sound manner. This is a decision that will have to be made by society over the next few years. (auth)

SYSTEMS STUDIES AND TOTAL ENERGY

5041 (BNL—20567) **Some comments on energy accounting.** Hoffman, K.C. (Brookhaven National Lab., Upton, N.Y. (USA)). Oct 1975. 7p. (CONF-751107—14). Dep. NTIS $4.50.

From 68. annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

Analytical techniques employed by economists, engineers, and scientists to gain insight into the role of energy in economic and societal development are reviewed and compared with traditional economic analysis. It is concluded that net energy analysis, which considers the input of energy, capital, materials, land, and labor required for the operation of a process, may be a useful complement to conventional engineering and economic analysis. Recommendations are made for developing energy system/input-output models. (LCL)

SUPPLY, DEMAND, AND FORECASTING

5042 (BNL—20354) **Interface equations for 110 sector input - output model.** Tessmer, R.G. Jr. (Brookhaven National Lab., Upton, N.Y. (USA)). Jul 1975. 46p. Dep. NTIS $5.00.

Brookhaven's energy input-output (I/O) model of the national economy now exists in two formats. The first is a 101 sector model structured for analyses within a 1976-to-1980 time framework. New, emerging energy technologies are not included as specific I/O sectors. The second format is a 110-sector model structured for analyses within a 1985 time framework. Five emerging energy technologies are included as specific I/O sectors: shale oil retorting, high-Btu coal gasification, HTGR electric generation, low-Btu coal gas combined gas/steam cycle electric generation, and solvent-refined coal/steam electric generation. In addition, the following two I/O sectors have been disaggregated into seven sectors: new construction and maintenance/repair construction. Two sets of A-matrix coefficients are available for use - historical 1967 BEA (Bureau of Economic Analysis) numbers, and projected 1985 numbers from the Bureau of Labor Statistics. The interface equations for the 110 sector model are documented and differences in units of measurement for energy supplies between BESOM (Brookhaven Energy System Optimization Model) and the I/O are identified. Differences occur because the linear program model is formulated in terms of domestic consumption whereas the I/O is formulated in terms of domestic production. The difference between these measures is accounted for by exports, imports, and inventory change of energy resources. Units of measurement do not differ for energy products because both BESOM and the I/O are formulated in terms of domestic consumption. (from Introduction)

5043 (BNL—20448) **Linear programming and technology assessment.** Cherniavsky, E.A. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 9p. (CONF-750736—1). Dep. NTIS $4.00.

From SIMS research application conference; Alta, Utah, USA (7 Jul 1975).

The Brookhaven Energy System Optimization Model is a linear programming model that was developed in order to provide a tool for energy technology and policy assessment. The model has been used to evaluate the impacts of new technologies on the energy system, and to analyze the effects of sets of assumptions, or scenarios, in a given planning year. The flow of energy from a resource to the point of end use can be depicted by a network diagram or reference energy system. The raw resource may have to undergo several processes before it can be used to satisfy energy demands. Each process: extraction, refining, transport, central station conversion, transmission and distribution, decentralized conversion, and utilization, has associated with it a vector of effects including cost, environmental impacts, and energy losses. The effects associated with a path in the network diagram from a resource to an end use are obtained by summing up the effects of each process on the path. Every variable in the linear programming model represents the flow of energy in 10^{15} Btu from some resource to meet a particular demand. Each path in the reference energy system can be divided into two parts: a supply trajectory describing the conversion of a resource into an intermediate energy form such as electricity or distillate oil delivered to the home, and a demand trajectory including all further processes on the path. The variable is identified with the level of the intermediate energy form, which is usually energy at the point of end-use, e.g., transmitted and distributed electricity. In the linear programming model, there are 27 supply trajectories or supply categories, and 22 demand categories. (auth, Introduction)

5044 (BNL—20501) **Energy systems analysis and technology assessment program. Annual report, fiscal year 1975.** Beller, M. (ed.). (Brookhaven National Lab., Upton, N.Y. (USA)). Sep 1975. 136p. Dep. NTIS $5.45.

Progress on model development, planning tasks, and technical support is reported for 1975. A new base year (1972) Reference Energy System (RES) was developed and new RES's were projected for 1980, 1985, 1990, 2000, and 2020. These systems are based primarily upon existing technologies and Future Energy Systems were developed that incorporate new technologies under development, i.e., coal gasification and liquefaction, shale oil, and the LMFBR. The optimization model (BESOM) includes the same input parameters that are used in the RES and is used for more extensive analyses where optimization is desired. The model encompasses the entire energy system and reflects the full feasible range of interfuel substitutability including electrical and nonelectrical energy forms. It focuses on the technical, economic, and environmental characteristics of the energy conversion, delivery, and utilization devices that make up the energy system. The effort on coupling BESOM with the University of Illinois Input-Output model is explained. The linkage of BESOM with a macroeconomic industrial growth model at Data Resources, Inc. is discussed. Further modeling progress is reported on the initiation of a Reference Material Systems (RMS) to provide a framework for analysis of substitution of materials and related energy, environmental, and economic factors. An interfuel substitution study was completed that evaluated an intensive electrification strategy based on the use of coal and nuclear power to reduce dependence on oil and gas in 1985 and 2000. Technical assistance was provided in the following areas: six sets of scenarios for 1985 and 2000 were prepared for ERDA use in an R and D budget plan; a study was conducted of Swedish energy use and compared to the U.S.; and an outline of H. T. Odum's net energy concept was prepared. (MCW)

5045 (BNWL-SA—5565) **Technology in the future: energy.** Schmid, L.C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 6p. (CONF-7410142—1). Dep. NTIS $4.50.

From Conference on energy technology in the future; Richland, Washington, USA (8 Oct 1974).

The energy problem must be solved by proper policy and management. In creating long-term solutions to the energy problem facing the U.S., the basic facts that must be considered are: (1) U.S. consumption of energy is very large and increasing rapidly; (2) less-costly fuel supplies are running out; and (3) concern is growing for the social and environmental impact of energy generation, conversion, transportation, and use. These factors are beginning to result in: (a) some shortages of energy, especially electrical power and natural gas; (b) increased energy costs; (c) growing dependence on foreign supplies of fuel; and (d) consideration of social and environmental aspects of energy production, as well as technical and economic ones. Over the next ten years we can expect the need for energy to raise prices generally, change lifestyles, provide environmental battles, and hamper economic progress. Technology must help the U.S. become more independent of foreign oil and natural gas over the next twenty to thirty years by reducing demand through conservation efforts, developing domestic supplies of oil and gas, and using more coal and uranium. For the longer term, renewable resources such as solar, geothermal, and fusion must be developed. A comparative evaluation of the utilization of petroleum, natural gas, coal, hydropower, and waste and wood is made for world consumption, U.S. consumption, and consumption in the Pacific Northwest (Idaho, Oregon, and Washington) for 1970. The Pacific Northwest has no significant natural gas or oil and only a few coal reserves; it is expected that coal and nuclear will provide 56 percent of their electrical generation by the year 2000, with the importation of Montana coal; hydropower, now supplying 41 percent of the energy needs, is expected to produce only 12 percent by the year 2000. (MCW)

POLICY, LEGISLATION, AND REGULATION

5046 (BNL—20435) **Energy facility location: a regional viewpoint.** Meier, P.M. (Brookhaven National Lab., Upton, N.Y. (USA)). Aug 1975. 72p. Dep. NTIS $5.50.

This essay argues three energy-planning imperatives: (1) that there exists a series of energy-siting issues that are best addressed at the regional scale; (2) that the complex interactions between energy policy options preclude a simplistic isolation of siting issues from other energy issues of regional concern; and (3) that in the absence of an appropriate articulation of the regional perspective, important policy decisions will be made by inappropriate levels of government without giving adequate weight to the interests of the region as a whole. Particular attention is given to the role of litigation in siting issues, the shortcomings of some of the siting methodologies currently in fashion, and an identification of major areas of scientific uncertaintly and institutional interactions still constraining regional decision making in the siting process. 115 notes (auth)

5047 (ERDA—82(Vol.1)) **Legislative history on P.L. 93-438: energy reorganization act of 1974. Volume I.** Diggin, D. (comp.). (Energy Research and Development Administration, Washington, D.C. (USA)). 1974. 842p. Dep. NTIS $45.25.

The Tables of Contents of the six volumes are printed at the beginning of Volume 1, followed by a synopsis of the legislative action on P.L. 93-438 from June 29, 1973 to January 15, 1975. Some important actions include the introduction of H. R. 9090 (Energy Research and Development Administration Act) by Mr. Holifield and Mr. Horton (by request) which was referred to the Committee on Government Operations on June 29, 1973, after the President issued his Energy Statement concerning national energy needs and proposals for energy reorganization. On July 10, 1973, S. 2135 (Energy Research and Development Administration Act) was introduced in the Senate, read twice, and referred to the Committee on Government Operations. The Energy Reorganization Act of 1973 (H.R. 11510) was introduced in the House on Nov. 15, 1973 and the Energy Reorganization Act of 1973 (S. 2744) was introduced in the Senate on Nov. 27, 1973. The congressional actions to May 30, 1974 are contained in Volume 1. Some recommended amendments are included. (MCW)

5048 (ERDA—82(Vol.2)) **Legislative history on P.L. 93-438: energy reorganization act of 1974. Volume II.** Diggin, D. (comp.). (Energy Research and Development Administration, Washington, D.C. (USA)). 1974. 878p. Dep. NTIS $47.00.

Volume 2 begins with a confidential committee print on S. 2744, dated June 5, 1974. Markups are shown. All amendments are cited. On August 26, 1974, a Committee Print compared H.R. 11510 as Passed by the Senate and as Passed by the House was printed. Volume 2 concludes with the agenda for conference H.R. 11510 Draft. On September 23, 1974, the House disagreed with the amendments of the Senate to H.R. 11510 and agreed to a conference asked for by the Senate. Appointed as conferees were Mr. Holifield, Moorhead of Pennsylvania, St. Germain, Fuqua, Horton, Wydler, and Brown of Ohio. (MCW)

5049 (ERDA—82(Vol.3)) **Legislative history on P.L. 93-438: energy reorganization act of 1974. Volume III.** Diggin, D. (comp.). (Energy Research and Development Administration, Washington, D.C. (USA)). 1974. 737p. Dep. NTIS $40.00.

Volume 3 begins with hearings on October 2, 1974, on H.R. 11510 to resolve the differences between Senate and House passed versions of the bill. No final agreement was reached. Further proceedings and discussions are published until H.R. 11510 (Enrolled Bill) was signed by the Speaker of the House and was presented to the President for approval on October 11, 1974. Volume 3 also contains the hearings before a Subcommittee of the Committee on Government Operations on H.R. 9090 on July 24, 25, 26, 31; and August 1, 1973. Five appendices include additional information on the legislation. Specifically, H.R. 9090 is "to promote more effective management of certain related functions of the executive branch by reorganizing and consolidating those functions in a new Department of Energy and Natural Resources, by reorganizing and consolidating others in a new Energy Research and Development Administration, and for other purposes." Hearings were conducted before a subcommittee on Nov. 27, 28, and 29, 1973 on H.R. 11510. Additional statements on Energy Research and Development Administration and related matters submitted for the record are contained in an appendix. Information on the NSF/Rann Solar Energy Research grants and contracts for FY 1973 and FY 1974 is compiled. Some additional statements on H.R. 11510 from industry complete the volume. (MCW)

5050 (ERDA—82(Vol.4)) **Legislative history on P.L. 93-438: energy reorganization act of 1974. Volume IV.** Diggin, D. (comp.). (Energy Research and Development Administration, Washington, D.C. (USA)). 1974. 700p. Dep. NTIS $38.00.

Volume 4 begins with some additional statements from industrialists and professional societies on the Energy Reorganization Act of 1973, H.R. 11510. Specifically, H.R. 11510 is "to organize and consolidate certain functions of the Federal government in a new Energy Research and Development Administration and in a Nuclear Energy Commission in order to promote more efficient management of such functions." Then begins the hearings to establish an Energy Research and Development Administration and a Nuclear Energy Commission before the Subcommittee on Reorganization, Research, and International Organizations of the Committee on Government Operations, United States Senate, 93rd Congress, First Session, on S. 2744, Dec. 4, 5, and 10, 1973. An appendix contains the text of S. 2744 and additional comments, remarks, statements, letters, and charts. (auth)

5051 (ERDA—82(Vol.5)) **Legislative history on P.L. 93-438: energy reorganization act of 1974. Volume V.** Diggin, D. (comp.). (Energy Research and Development Administration, Washington, D.C. (USA)). 1974. 375p. Dep. NTIS $21.75.

Volume 5 begins with hearings before the 93rd Congress, Second session, on S. 2135 to establish a Department of Energy and Natural Resources and S. 2744 to establish an Energy Research and Development Administration and a Nuclear Safety and Licensing Commission, Feb. 26, and 27 and March 12, and 13, 1974. Some witnesses heard on those days were William E. Simon, S. David Freeman, Joseph Fisher, Theodore B. Taylor, Steven Ebbin, Hon. Frank E. Moss, Donald R. Cotter, and Dixy Lee Ray. Persons accompanying these officials and their testimony are published. Mr. William E. Kreigsman responded to queries submitted in writing. Texts of S. 2135 and S. 2744 are published in an appendix. Additional comments, remarks, statements, letters, and charts are also included. (MCW)

5052 (ERDA—82(Vol.6)) **Legislative history on P.L. 93-438: energy reorganization act of 1974. Volume VI.** Diggin, D. (comp.). (Energy Research and Development Administration, Washington, D.C. (USA)). 1974. 394p. Dep. NTIS $22.75.

Volume 6 is a review of all references to remarks on Energy Reorganization in the Congressional Record from June 30, 1973 beginning with remarks by Mr. Cook in reference to the President's Energy Message of June 29, 1973 to the remarks of Mr. Muskie on ERDA and Passamaquoddy, on Oct. 11, 1974, the day Public Law 93-438 is listed as being signed by the President. The White House Release is included, followed by an announcement by US AEC. Congressional Record material from June 30, 1973 to Oct. 15, 1974 is presented. A special RAPPORT issue announces the proposals for energy reorganization and the AEC role. (MCW)

ENVIRONMENT

5053 (BNL—20489) **Research in energy facility siting.** Meier, P.M. (Brookhaven National Lab., Upton, N.Y. (USA)). Jul 1975. 24p. Dep. NTIS $4.00.

The report describes the research in energy facility siting at Brookhaven National Laboratory conducted under the Regional Energy Studies Program (RESP). The first task in the siting program is an articulation of the regional perspective. Work selected for attention in the initial stages of the background research program includes an analysis of water resource constraints on thermal power facilities in the Northeast; an assessment of the economic feasibility of artificial islands for offshore energy facilities; an investigation of nuclear fuel cycle management problems in the Northeast; a review and assessment of mathematical models for oceanic pollutant transport; and a review of scale economies and production costs in the electric sector. The second task will focus on the development of siting methodologies suitable for regional scale analysis emphasizing (1) an examination and extension of modern quantitative planning techniques as a basis for facility siting models and (2) an examination of existing energy planning models that do not currently address either the regional scale or location problems, but which do have the ability to consider energy policy questions of interest to the RESP. The third task addresses two areas: (a) analysis of the siting decision-making process as exemplified in New Jersey, with emphasis on gaining a better understanding of utility decision-making and the complex interrelationships between the utilities and the Federal and State regulatory agencies; (b) and a study of regionalization and regional energy planning as a political process. Finally, policy analyses focus on two assessments: clustered vs dispersed siting, in particular on the feasibility of Nuclear Energy Centers in the Northeast; and the impact of offshore oil development on the Northeast's energy future. (MCW)

5054 (JUL—1213) **Environmental effects of alternative energy policies: a model study with consideration of sociological influences.** Elsinghorst, D. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany)). Jun 1975. 161p. (In German). Dep. NTIS (US Sales Only) $7.75.

Thesis. Submitted to Technische Hochschule, Aachen.

The exponential increase in energy consumption has increased the possibility of polluting air and land so much that the detrimental external effects of economic activities must be regarded in energy modeling. This means analyzing the interdependent connections between the economic system and the environment and picturing the structure of the real system on a mathematical model; to do this, system dynamics models were developed. Beside the relevant technical variables, sociological variables such as "public pressure" or "lobby pressure" were considered. So it was possible to refute the "ceteris paribus" assumption of the constant sociological and political influences. The environmental effects of various policies to meet the energy demand were critically examined in simulation runs. It was demonstrated that the pollution of the atmosphere will decrease in the beginning of the 1980's. This is based on the implementation of a new energy technology with a lower pollution and on the increasing amount of pollution control. (auth)

ENERGY RESOURCES

5055 (ERDA—53) **World energy resources: an annotated bibliography of selected material on the availability and development of world energy resources.** (Energy Research and Development Administration, Washington, D.C. (USA)). 1975. 21p. Dep. NTIS $4.50.

The bibliography provides references to 173 recent English language publications covering the availability and development of world energy resources. Citations dealing exclusively with energy resources of the United States have been omitted. The references are sources of statistical and general energy policy information, not technical descriptions of resource development. Most of the items chosen (from books, journal articles, and reports) were published since 1972. The bibliography is divided into sections and within sections by year of publication and then alphabetically by title. The four general sections include citations that cover several types

of energy resources in more than one country. Citations of energy resources in more than one country are given for coal, peat, oil shale, tar sands, petroleum, natural gas, geothermal, hydraulics, nuclear energy, solar energy, ocean thermal gradients, tidal power, wind power, and wastes. Then entries that deal exclusively with the resources of each of 27 countries are listed. An author index is included. (MCW)

5056 (LA—6107-MS) **1974 Rocky Mountain energy flow patterns.** Kidman, R.B. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. Contract W-7405-ENG-36. 14p. Dep. NTIS $4.00.

Highly visual and self-explanatory 1974 energy flow diagrams are presented for each of the eight Rocky Mountain States and for the Region as a whole. Each diagram is essentially an accounting of the energy produced and how it is consumed or lost. The diagrams are meant to serve as a convenient and useful reference (or starting point) for consideration of energy-related questions. (auth)

5057 (LA—6139-MS) **Preliminary report on local impact model.** Bruckner, L.A.; McKay, M.D. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1975. Contract W-7405-eng-36. 17p. Dep. NTIS $4.00.

Within the framework of a regional energy study, models that can be used to study local impacts of energy development are being developed. This presentation describes initial efforts toward the development of a Linear Programming model. As a test case the energy development in the Four Corners region of northwest New Mexico is being studied. The development centers around the Navajo Nation's option to allow construction of coal gasification plants, electric power generating stations and coal mines, and the potential interplay with the Navajo Indian Irrigation Project, Navajo employment, and community growth. The model attempts to find construction timetables for the various industries that allow orderly community growth. Natural resource, labor, financial, supporting business, and municipal service constraints are imposed. Although the state of development of the model is still very crude, this progress report will serve to inform others of its status and hopefully generate a productive dialogue on the general question of local impact. (auth)

FOSSIL FUELS

COAL

5058 **Methanol from coal: a step toward energy self-sufficiency.** Harney, B.M. (Energy Research and Development Administration, Fossil Energy, Washington, DC). *Energy Sources;* 2: No. 3, 233-249(1975).

The current domestic energy shortage has resulted in a number of evaluations of technologies that might provide clean fuels from coal in an early time frame. The production of methanol from coal holds unique potential as a means of using a technology that is commercially available for producing a versatile fuel that can be used in automobiles, electric power plants, gas turbines, and fuel cells. A methanol-from-coal process involves gasification of coal to produce synthesis gas (carbon monoxide and hydrogen), followed by catalytic conversion to produce methanol. Gasification and methanol conversion technologies are reviewed and the integration of the two systems is discussed. The possible uses of methanol fuel are also discussed. Economic analyses from a number of sources (using 1973 dollars) indicate that at a 12 percent discounted cash flow rate methanol could be produced for between $0.13 and $0.20/gal ($2.02 and $3.08/million Btu), depending on coal cost, gasification and methanol conversion scheme, location of plant, and other factors. 22 references. (auth)

5059 **Energy recovery from in situ coal gasification.** Fischer, D.D.; Brandenburg, C.F.; Schrider, L.A. (Laramie Energy Research Center, WY). *Energy Sources;* 2: No. 3, 281-292(1975).

From American Society of Mechanical Engineers' 15. Annual Symposium, In Situ Fossil Fuel Recovery; Albuquerque, NM, USA (6 Mar 1975).

Estimates of the energy balance for the first underground coal-gasification experiment at Hanna, Wyoming, have been calculated for a $5^1/_2$-month period from mid-September 1973 through February 1974. Operating results were the most favorable during this period, with dry gas production rates averaging 1.6 million scf/day (45,300 Nm^3/day) at an average gas heating value of 126 Btu/scf (1122 kcal/Nm^3). The ratio of energy produced to energy consumed in running the experiment was approximately 4, and the overall efficiency was approximately 50 percent. Use of more efficient air-compression equipment and of a system designed for combustion of low-Btu gas could increase this ratio to 8 and efficiency to 55 percent. (auth)

OIL SHALES AND TAR SANDS

5060 **Experimental approach to in situ oil recovery from tar sands.** Marchant, L.C.; Land, C.S.; Cupps, C.Q. (Energy Research and Development Administration, Laramie, WY). *Energy Sources;* 2: No. 3, 293-309(1975).

The shrinking of energy supplies from traditional resources makes it imperative that all practical energy resources be developed to meet the energy demands of this country. Recovery of oil from domestic tar sands is being investigated for this purpose, and is part of the Laramie Energy Research Center's research program on unconventional energy resources. Results of laboratory experiments are discussed which indicate applicability of the reverse combustion process for in situ oil recovery from tar sands. Some characteristics of Utah tar sands as determined from core analysis are described. The design is described for a field experiment to evaluate application of reverse combustion for in situ oil recovery from tar sand in the Northwest Asphalt Ridge deposit in Utah. (auth)

UNCONVENTIONAL SOURCES AND POWER GENERATION

SOLAR

5061 **Largest U.S. solar system experiment installed in an Atlanta school.** *Aware;* No. 64, 2-4(Jan 1976).

The nation's largest solar heating and cooling system, currently in operation, was dedicated November 26, 1975 at the 660-pupil George A. Towns Elementary School in Atlanta, Georgia. The Atlanta locale typifies the climatic and insolation (solar radiation) characteristics of a large portion of the United States where seasonal heating and cooling loads are about balanced. The school, constructed in 1962, was selected as the site of this experiment for several reasons. The one-story building faces south so that roof-mounted solar collectors will face the noonday Sun, and the building has 32,000 square feet of flat-roof area capable of supporting the solar array. The school was heated previously by pumping hot water from a gas-fired boiler to room unit ventilators. Although the room unit ventilators were originally designed to accommodate both hot and chilled water, the planned lithium bromide absorption chiller had never been installed. Thus, the existing room unit ventilators could accept either hot or chilled water and could be used with minimum modification for the experiment. Furthermore, the school's existing gas-fired low-pressure boiler can provide all auxiliary heat required to supplement the solar system for both heating and cooling. Principal components of the solar heating and cooling system designed for the school are the solar collector array, the existing gas-firedboiler, the absorption chiller, and hot and cold water underground tanks to provide thermal storage. System installation was completed in September 1975 and will be monitored for 12 months, at which time an analysis will be made. The project is not expected to produce a currently cost-competitive system, but to provide experience that will lead to development of such a system. (MCW)

GEOTHERMAL

5062 **Geothermal Federal loan guarantee program (Federal Register).** *Geotherm. Energy Mag.;* 3: No. 11, 33-35; 37-39(Nov 1975).

The proposed regulation is concerned with lenders being able to obtain Federal guaranties on loans to qualified borrowers for purposes related to the commercial development of practical means to produce electric power and other forms of useful energy from geothermal resources. (auth)

ELECTRIC POWER GENERATION

5063 **Environmental policies for electricity generation: a study of the long-term dynamics of the SO_2 problem.** Ford, A. (Dartmouth Coll., Hanover, NH). *Energy Syst. Policy;* 1: No. 3, 287-304(1975).

The problem of SO_2 emissions from power plants has been and could continue to be a serious constraint to the increased use of coal to generate electricity during the next 30 to 50 years. A dynamic model has been constructed to determine the likely severity of the restrictions on coal use and to analyze the effectiveness of alternative political, economic, and technical policies designed to reduce the severity of the SO_2 constraint. Endogenous variables in the model include: economic costs, perceived damage from SO_2, reliability of stack gas abatement technologies, investment in scrubbers, society's clean air goal, and other related fac-

tors. The model has been simulated on the computer to determine its behavior under the following possible policy options: (1) slowdown in nuclear power plant construction, (2) retrofitting existing coal-fired plants with scrubbers, (3) relaxation of sulfur content restrictions, and (4) reduction of the total demand for electricity. 24 references (auth)

CONSUMPTION AND UTILIZATION

5064 (BNL—20539) **Comparative analysis of energy use in Sweden and the United States.** Doernberg, A. (Brookhaven National Lab., Upton, N.Y. (USA)). Sep 1975. 47p. Dep. NTIS $4.00.

The major body of this report begins with a general comparison of energy-use patterns in the U.S. and Sweden and is followed by a more detailed review of energy utilization in Sweden that provides the basis for the comparative analysis. The report concludes with the development, for heuristic purposes, of a conservation strategy for the U.S. that is based on the Swedish experience. This strategy is not proposed in any sense as a "best" strategy for the U.S. The development and comparison of alternative strategies for the U.S. will be the subject of another study. The strategy developed here does represent a reasonable option and provides considerable insight into the elements of a comprehensive conservation strategy. The major conclusions are: (1) the largest difference between the two countries per capita energy use is in the transportation sector; (2) the achievement of a 40 percent reduction in U.S. consumption by the year 2000 according to the strategy outlined will be difficult and will have significant effects on life styles and the structure of the U.S. economy; (3) more detailed analysis is needed to determine comparative life styles and standards of living; and (4) the major technological factors that are involved in the U.S. - Sweden comparison are district heating and hydropower. The analysis performed in the study focused on direct energy consumption. It is necessary to give more consideration to the energy embodied in import and export goods in order to make a more meaningful comparison between the internal energy consumption of two countries. (MCW)

5065 (BNL—20572) **Enthalpy management in buildings: an analysis and an integrated approach.** Berlad, A.L.; Salzano, F.J.; Batey, J. (Brookhaven National Lab., Upton, N.Y. (USA)). Jul 1975. 47p. Dep. NTIS $5.45.

Enthalpy management requirements of residential and small commercial buildings are analyzed, and integrated approaches to energy-efficient and cost-effective heating and cooling schemes are proposed. Improved design and operating strategies are suggested to make more efficient use of off-the-shelf (or other readily accessible) technology for space conditioning. Thermal storage devices, techniques, and special operational strategies are central to these approaches. Fossil-fuel heaters, heat pumps, solar collectors, electric driven air coolers, all can be used more efficiently when effectively interfaced with selected thermal storage systems. A central heated (fossil fuel) and cooled (electric air conditioner) residence located in Long Island, New York, is considered as an example. It is found that the revised operating approach leads to 50 percent savings in space conditioning costs, with the basic functional features of the building unchanged, and assuming it is no better insulated than a typical well-insulated frame residence. Additional insulation results in further savings. 19 references (from Summary)

ENERGY CONVERSION

MHD GENERATORS

DESIGN AND DEVELOPMENT

5066 (ANL/ENG—76-02) **Tin-steam MHD power system. Volume I. Progress report, February—August 1975.** Petrick, M.; Hantman, R.; Snyder, B.K.; Kassner, T.; Ruther, W. (Argonne National Lab., Ill. (USA)). Sep 1975. Contract NR-099-404/2-75. 63p. Dep. NTIS $5.50.

During fiscal year 1975 Argonne National Laboratory, under an agreement with the Defense Advanced Research Projects Agency (DARPA) has engaged in conceptual studies of a tin-water MHD Prototype Power System. This system has several advantages that make it especially attractive for application in large submersibles. In addition to being compatible with present day light water reactors and having the potential for producing very substantial reductions in weights and volumes for given power levels when compared to present-day systems, it also possesses the potential for increased system reliability and reduced noise levels, since the few rotating parts are of small size and will rotate at relatively low velocity. The FY 75 activities included cycle and system studies, pre-conceptual design studies and development of detailed program plans. The results of the cycle and system studies and tin-water oxidation studies conducted in FY 75 are described. (WHK)

5067 (ANL/ENG—76-03) **Tin-steam MHD power system. Volume II. Progress report, February—August 1975.** Petrick, M.; Snyder, B.K.; Hantman, R.; Kassner, T.; Carlson, L.; Zinneman, T. (Argonne National Lab., Ill. (USA)). Sep 1975. Contract NR-099-404/2-75. 164p. Dep. NTIS $7.75.

During fiscal year 1975 Argonne National Laboratory, under an agreement with the Defense Advanced Research Projects Agency (DARPA) has engaged in conceptual studies of a tin-water MHD Prototype Power System. This system has several advantages that make it especially attractive for application in large submersibles. In addition to being compatible with present day light water reactors and having the potential for producing very substantial reductions in weights and volumes for given power levels when compared to present-day systems, it also possesses the potential for increased system reliability and reduced noise levels, since the few rotating parts are of small size and will rotate at relatively low velocity. The FY 75 activities included cycle and system studies, pre-conceptual design studies and development of detailed program plans. A conceptual reference design for a 1 MW (thermal) Sn—H_2O MHD Prototype Power System, the program plan for the R and D, design and construction of such a system, and time schedules and budgets are described. (WHK)

5068 (FE—1760-1) **Development program for MHD direct coal-fired power generation test facility. Quarterly progress report, January—March 1975.** Dicks, J.B.; Tempelmeyer, K.E.; Wu, Y.C.L.; Crawford, L.W.; Loeffler, N.L. (Tennessee Univ., Tullahoma (USA). Space Inst.). 31 Mar 1975. Contract E(49-18)-1760. 66p. Dep. NTIS $5.50.

This report contains information (a) on UTSI MHD generator test program for the past quarter, (b) on an analytical model of the slag-layer formed in the generator, (c) on a simple kinetic model of the slag/seed interaction, and (d) on the status of the materials research program. Progress made on each of the active Tasks of the program is reviewed together with the present status of the program. In addition, the anticipated progress for the next quarter is summarized. (auth)

5069 (FE—1760-10) **Development program for MHD direct coal-fired power generation test facility. Quarterly technical progress report, July—September 1975.** Dicks, J.B.; Tempelmeyer, K.E.; Wu, Y.C.L.; Crawford, L.W.; Muehlhauser, J.W.; Martin, J.F.; Heimlich, I.R. (Tennessee Univ., Tullahoma (USA). Space Inst.). 14 Oct 1975. Contract E(49-18)-1760. 67p. Dep. NTIS $5.50.

Progress was made in the measurement and analysis of the interaction of slag and seed material. A number of slag/seed separation tests were carried out with potassium sulfate seed, potassium carbonate seed, and with unseeded coal. Information was also obtained for the operation and performance of a radiant boiler, the slag/seed separation cyclone, and the characteristics which will be required for recovery of very fine particulate potassium sulfate fume which leads the slag/seed separation cyclone. A summary of the program milestones and schedule is given and the materials test program reviewed. (auth)

5070 (LA-tr—75-31) **Use of cumulative explosive charges in pulsed MHD generators.** Priakhin, G.V.; Titov, V.M.; Shvetsov, G.A. Translated by Helen J. Dahlby from *Din. Sploshnoi Sredy*; 3: 111-114(1969). 6p. Dep. NTIS $4.50.

A small test MHD generator using a gas-cumulative explosive charge creating a jet of detonation products of significant elongation (10 to 15 calibers of the charge channel) is discussed. (WHK)

5071 **Conceptual design and economics of an MHD pilot plant.** Bergman, P.D.; Plants, K.D.; Joubert, J.I.; Bienstock, D. (Energy Research and Development Administration, Pittsburgh). pp 513-523 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Cycle analyses and preliminary cost estimates are presented for two proposed design configurations of a 300 MWt coal-burning, open-cycle magnetohydrodynamic pilot plant. Cycle efficiencies ranged from 43 to 46 percent with a basic pilot plant cost $98 to 114 million. A directly fired design option is recommended as

the preferred path to pursue, because it is completely coal-based, and avoids the large-scale utilization of scarce and expensive clean liquid and gaseous fuels for power generation. Related topics including the use of oxygen enrichment, provision for a back-up system, and pilot plant scale-up are also discussed. (auth)

DUCT ENGINEERING AND FLUID DYNAMICS

5072 (JUL—1055-TP) **Applied magnetohydrodynamics. No. 13. Theoretical basis of MHD energy conversion with combustion gases.** Kolb, G.; Kuehne, W.D.; Blankenhorn, R. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Technische Physik). Mar 1974. 215p. (In German). Dep. NTIS (US Sales Only) $8.75.

The theoretical principles of combustion gas MHD generators are represented comprehensively. The physical and chemical processes in the combustion gas in the combustion chamber up to its discharge into the atmosphere are described. (JSR)

THERMOELECTRIC GENERATORS

DESIGN AND DEVELOPMENT

5073 (TID—24922) **SNAP 29 power supply system. Ninth quarterly progress report.** (Isotopes, Inc., Middle River, Md. (USA). Nuclear Systems Div.). Jan 1969. Contract AT(29-2)-2062. 336p. Dep. NTIS $11.00.

Declassified 2 Nov 1971.

Progress during the period from Oct. through December 1968 in the development of the SNAP 29 battery, a radioisotope-fueled thermoelectric generator (RTG) system for spacecraft power supplies, is reported. Information is included on: fabrication and testing of RTG components; systems evaluation and integration; reliability analysis and prediction; reentry trajectory and heating rates for various burn-up element configurations; and system safety evaluation. (LCL)

THERMIONIC CONVERTERS

5074 **ERDA thermionic program.** Newbt, G.A. (Energy Research and Development Administration, Washington, DC). pp 351-355 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Since the termination of the U.S. space thermionic reactor development program in the spring of 1973, considerable progress has been made in the U.S. thermionic research program. It is therefore appropriate that the rationale for continued government support of this work be addressed. The program objectives and principal problem areas are discussed. Also, the most important features of the development plan for the conduct of the program over the next few years and the efforts that should be maintained to coordinate the work of the various groups that will be working in the program are described. (auth)

DESIGN AND DEVELOPMENT

5075 (COO—2263-2) **Advanced thermionic energy conversion. Progress report, September 1, 1973—August 31, 1974.** Britt, E.J.; Fitzpatrick, G.O.; Hansen, L.K.; Rasor, N.S. (Rasor Associates, Inc., Sunnyvale, Calif. (USA)). 1974. Contract AT(11-1)-2263. 136p. Dep. NTIS $10.00.

During this reporting period basic analytical and experimental exploration was conducted on several types of advanced thermionic energy converters, and preliminary analysis was performed on systems utilizing advanced converter performance. The Pt--Nb cylindrical diode which exhibited a suppressed arc drop, as described in the preceding annual report, was reassembled and the existence of the postulated hybrid mode of operation was tentatively confirmed. Initial data obtained on ignited and unignited triode operation in the demountable cesium vapor system essentially confirmed the design principles developed in earlier work, with a few exceptions. Three specific advanced converter concepts have been selected as candidates for concentrated basic study and for practical evaluation in fixed-configuration converters. Test vehicles and test stands for these converters and a unique controlled-atmosphere station for converter assembly and processing were designed, and procurement has been initiated. System analysis has shown that the thermionic heat exchanger concept for topping of electric power plants is economically and technically attractive if 2nd generation converter performance is achieved, and if identified structural, heat transfer and output coupling innovations are reduced to engineering practice. (auth)

5076 **Electrodes for thermionic energy conversion.** Rufeh, F.; Sommer, A.H.; Huffman, F.N. (Thermo Electron Corp., Waltham, MA). Contract AT(11-1)-3056. pp 361-366 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Progress at the Thermo Electron Corporation on improving emitters and collectors for thermionic converters is reported. (WHK)

PERFORMANCE AND TESTING

5077 **Practical aspects of plasma processes in thermionic energy converters.** Rasor, N.S.; Hansen, L.K.; Fitzpatrick, G.O.; Britt, E.J. (Rasor Associates, Inc., Sunnyvale, CA). pp 367-375 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Over a decade of cesium vapor thermionic converter research has yielded sufficient understanding of the basic plasma processes to permit application of this understanding to improvement of converter performance. A performance index is defined which relates such converter improvements directly to increases in system performance. A prime practical objective of current research is to reduce or eliminate the arc potential drop presently required to sustain the plasma in the ignited cesium diode. This will substantially increase the energy conversion efficiency, and will permit operation at substantially lower emitter temperatures without requiring lower collector (heat rejection) temperature. Present work is concentrating on evaluating and reducing to practice the several methods employing auxiliary ion sources to eliminate the arc drop which were demonstrated over a decade ago: i.e., various ignited and unignited triode concepts, and the pulse-enhanced diode and triode. These methods are reviewed in light of present understanding and recent experimental data. (auth)

FUEL CELLS

DESIGN AND DEVELOPMENT

5078 **Method and means of generating power from fossil fuels with a combined plasma and liquid-metal MHD cycle.** Amend, W.E.; Cutting, J.C. (to U.S. Energy Research and Development Administration). US Patent 3,895,243. 15 Jul 1975. Filed date 12 Mar 1974. 6p.

PAT-APPL-450,519.

This patent relates to a method and means of generating power from fossil fuels with a combined plasma and liquid-metal MHD cycle. The heat required for operation of a two-phase liquid-metal MHD generator is obtained from the waste heat of a plasma MHD generator. The liquid metal is heated by passing it in heat exchange relationship to the combustion mixture exhausted from the plasma MHD generator and the inert gas is heated by cooling the walls of the combustion chamber and plasma MHD generator. (auth)

POWER CYCLES

BRAYTON

5079 **High efficiency power conversion cycles using hydrogen compressed by absorption on metal hydrides.** Powell, J.R.; Salzano, F.J.; Yu, W.S.; Milau, J.S. (Brookhaven National Lab., Upton, NY). pp 1339-1347 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

A new power conversion cycle is analyzed which uses H_2 gas as a working fluid in a regenerative closed Brayton cycle. In the proposed cycle, H_2 is compressed by cyclic absorption/desorption on a metal hydride bed instead of being mechanically compressed. Two thermal inputs are used: a low temperature

input (T approximately equal to 100°C), supplied by low grade solar geothermal heat, which operates the hydride compressor, and a high temperature heat input (T greater than 300°C), supplied by a nuclear reactor or fossil combustor. Almost all, i.e., approximately equal to 90 percent, of the high temperature heat input can be converted to electricity using current fossil or reactor technology. Approximately 3KW (th) of low grade heat input is required per KW(e) output. Besides conserving scarce nuclear and fossil resources, the proposed cycle should result in reduced capital costs for electric generation plants, as well as substantially lower total electric generation costs. The resource base of low grade geothermal and solar appears to be very large. Where low grade heat sources are available, existing power plants can be retro-fitted with the proposed cycle, which would increase output by a factor of 2 or more. Experiments with test iron-titanium compressors are described, along with experience on iron-titanium hydrogen storage reservoirs being developed for peak shaving applications in electrical generating systems. (auth)

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

5080 **Energy conservation in an urban center.** de Pass, V.E. (Consolidated Edison Co. of New York, Inc., New York). pp 695-704 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

In 1971, more than two years prior to the Middle East oil embargo, the Consolidated Edison Company of New York, Inc., being concerned about the nation's diminishing energy resource base and the harmful effect on the environment of wasteful use of power, disbanded its sales force and mounted instead a vigorous program called "Save A Watt." This conservation program stressed three themes: protect the environment, avoid shortages and save money. In short, the program's central point was--and remains--use all forms of energy wisely, do not waste any. Encouraged by the 1971 Save A Watt Program which helped reduce the summer peak load by about 200 megawatts Consolidated Edison has kept its Save A Watt appeal alive and has continually expanded it. But by the end of 1974 it was quite apparent that the Middle East oil embargo, and the resultant "Energy Crisis," had taken over as the principal contributing factor in the need to conserve energy. The year 1974 saw the sudden tripling of fuel costs while double-digit inflation helped to push customers' electric bills to new highs. In light of the high cost of energy and the basic need to conserve available energy it is essential that we re-examine and re-order our priorities in implementing the nation's clean air codes and water quality regulations. It is unconscionable to ask electric utility customers to pay, for example, for cooling towers that will decrease the reliability and availability of electric supply and may have their own negative environmental benefits. In addition, now is the time to win approval for a fuel policy that will permit the increased burning of less expensive fuels such as higher sulfur oil and domestic fuels such as coals. (auth)

BUILDINGS

5081 (BNL—20524) **Impact analysis for enthalpy management in building systems.** Braun, C. (Brookhaven National Lab., Upton, N.Y. (USA)). 25 Sep 1975. 19p. Dep. NTIS $4.50.

The potential impacts of four methods for reducing fuel consumption in the space heating of buildings are calculated. The results in terms of fuel oil and dollars saved are summarized. The fuel conservation methods include: improving the efficiency of oil-fueled space heating equipment; thermal insulation and improved dynamic operation of both new and existing masonry buildings; and the utilization of off-peak electric power in conjunction with thermal storage devices for space heating. (LCL)

TRANSPORTATION AND PROPULSION

LAND AND ROADWAY

5082 (ERDA—64, pp 103-105) **Factors influencing vehicle fuel economy of conventional autos.** Murrell, J.D. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

New information is presented on the effect of emission controls on fuel consumption and alternative engines in 1975 cars. Vehicle weight, engine displacement, and driving habits and conditions affect fuel consumption greatly, while there is no correlation between fuel economy and emission control. Tampering with emission controls is more likely to decrease fuel economy than improve it. (PMA)

INDUSTRY

ENERGY SOURCES

5083 (ORNL-TM—5070) **Impact of increased fuel costs and inflation on the cost of desalting sea water and brackish waters.** Reed, S.A. (Oak Ridge National Lab., Tenn. (USA)). Dec 1975. Contract W-7405-eng-26. 22p. Dep. NTIS $5.00.

The combined increases in the cost of fuel, equipment, and money during the past four years have had a marked impact on the cost of desalting saline waters. Results are presented of a parametric study made to estimate the current costs of desalting sea water by distillation and reverse osmosis and brackish waters by reverse osmosis and electrodialysis as a function of plant size and feedwater chemistry. Typically, distillation plant capital costs have increased from $1 per daily gallon to $3 per daily gallon for large plants (100 Mgd) and from approximately $1.40 per daily gallon to approximately $5 per daily gallon for plant sizes of 5 Mgd or less. Consequently, water costs are now ranging from $3 to $4 per 1000 gal when oil is used to generate steam. Similarly, the costs of desalting inland brackish waters using reverse osmosis or electrodialysis have increased significantly. (auth)

MATERIALS

5084 (JUL—1236(Pt.1)) **Chances for a long-term safe raw material supply for the German Federal Republic. Part I.** (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany)). Sep 1975. 42p. (In German). Dep. NTIS (US Sales Only) $5.00.

The Federal Republic of Germany is almost completely dependent on raw material imports. Growing raw material consumption and an imminent increase in supply uncertainties will require intensified research and development work in the field of raw material safeguarding. Initial approaches to possible technical solutions are being indicated in connection with four raw materials (aluminium, copper, phosphate, and carbon carriers). The material balances of these raw materials are shown and the technical and economic interrelations illustrated in the light of worldwide trends. It is demonstrated that two essential objectives are to be pursued for securing raw material supplies: extension of the raw material basis for primary and secondary raw materials and improvement of raw material utilization in all sectors of economy. To provide a solution for the wide spectrum of tasks it will be necessary to establish adequate analytical methods and procedures. (tr-auth)

EQUIPMENT AND PROCESSES

5085 (AECL—5235) **Temperature distribution of the energy consumed as heat in Canada.** Puttagunta, V.R. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Oct 1975. 49p. Dep. NTIS (US Sales Only) $5.00. AECL $1.50.

The amount of energy consumed as heat (excluding thermal generation of electricity) in Canada is estimated from statistical data available on the total consumption of energy for the years 1958 to 2000. Based on some actual plant data and other statistical information this energy consumption is subdivided into four temperature categories: high (greater than 260°C), intermediate (140 to 260°C), low (100 to 140°C), and space heating (less than 100°C). The results of this analysis show that approximately half of all the energy consumed in Canada has an end use as heat. Less than 10 percent of the energy consumed as heat is in the high temperature category, 12 to 14 percent is in the intermediate temperature range, 21 to 27 percent is in the low temperature range, and 50 to 58 percent is used for space heating. Over 90 percent of the energy consumed as heat in Canada is within the temperature capability of the CANDU-PHW reactor. (auth)

WASTE MANAGEMENT

5086 (CONF-751107—9) **Integrated waste management systems: onsite MIUS applications.** Rothenberg, J.H.; Mixon, W.R.; Boegly, W.J. (Oak Ridge National Lab., Tenn. (USA)). 1975. 19p. Dep. NTIS $4.50.

From 68. annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

Each of the major utility subsystems of the Modular Integrated Utility System (MIUS) were examined with respect to the potential for integration with other subsystems and the advantages resulting from such integration. The conclusions represent a current summary of results from evaluation studies of major components and subsystems applicable to MIUS, systems analyses comparing MIUS to conventional utilities serving identical consumer models, and assessments of impacts from application of the MIUS concept. (auth)

5087 (LBL—4408) **Preliminary cost analyses for enzymatic hydrolysis of newsprint.** Wilke, C.R.; Yang, R.D.; Von Stockar, U. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-ENG-48. 44p. (CONF-750992—2). Dep. NTIS $5.00.

From Symposium on enzymatic conversion of cellulosic materials; Boston, Massachusetts, USA (8 Sep 1975).

A tentative process for enzymatic treatment of newsprint with T. viride cellulase is presented. Results of a preliminary experiment for enzyme production by recycled cells are used as a basis for the process design. Although cost analyses suggest that it should be feasible to produce sugars in this manner, additional basic research and pilot plant studies will be needed to develop the method to the point of large scale industrial application. (auth)

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

SPARK-IGNITION

5088 (ERDA—64, pp 41-61) **Turbo compounding the spark ignition engine.** Palmer, R.M. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A program was initiated to study and design the most efficient means of utilizing the exhaust energy from a spark ignition engine by compounding. Emphasis is on achievable fuel economy; emissions are considered but not at the expense of thermodynamic performance. The program is organized in two phases, trade-off studies and modified engine tests, and results of the program (which is about 60 percent complete) are reported. (auth)

TURBINE

5089 (ERDA—64, pp 106-134) **Baseline engine project.** Wagner, C.E.; Mercure, P.K.; Ball, G.A. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

One and one-half years remain of a four year project to develop design improvements for automotive gas turbine engines and to build an upgraded engine which incorporates these new design features. Specific design goals involve engine cost, exhaust emissions, and fuel consumption. Design improvements achieved are discussed, including: (1) a burner giving low NO/sub x/ emissions; (2) a more effective ceramic regenerator; (3) a low cost turbine wheel; and (4) several engine design features with improved materials. (PMA)

5090 (ERDA—64, pp 134-143) **Baseline engine project support.** Heller, J.A.; Wong, R.Y. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A joint ERDA/NASA effort was continued to transfer aerospace technology to gas turbine vehicles in order to meet or better the 1978 Federal Emission Standards while showing improved fuel economy over conventional engines. Parametric analyses and trade-off evaluations were performed on the aerodynamic design of the compressor and turbines, and the results of these efforts are summarized. (PMA)

5091 (ERDA—64, pp 143-156) **Upgraded engine integrated control system.** LeFevre, H.P. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

An overview is given of specifications for a control system having full authority over gas turbine engine operation. The three major control loops, fuel control, power turbine nozzle control, and inlet guide vane control are discussed, and the logic switching for water injection, the start sequencing, and the engine protection package are shown. There are output provisions for diagnostic purposes, and estimated performance characteristics are presented. (PMA)

5092 (ERDA—64, pp 156-172) **Upgraded engine gas bearing program.** Gray, S. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A program was begun to design and test resilient, foil type hydrodynamic air and oil lubricated bearings for a generator rotor of an automotive gas turbine engine. An air lubricated journal bearing will be used for the turbine end, and oil lubricated journal and thrust bearings will be used for the compressor end of the rotor. The gas generator design with foil bearings resulting from these studies and the results of various performance tests are presented. (PMA)

5093 (ERDA—64, pp 173-181) **Advanced gas turbine performance analysis.** Klann, J.L. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A study was made to document the level of fuel economy to be expected from a 100 hp gas turbine-powered vehicle, and the growth potential of this propulsion system was examined. The design point values, the projected turbo-machinery efficiencies, and the projected net specific fuel consumption are presented. Results of the study indicate that support of a future technology program is warranted. (PMA)

5094 (ERDA—64, pp 181-199) **Ceramic rotors for small automotive gas turbine engines: technology assessment.** Katz, R.N. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

The most critical problem of mass producing ceramic automotive gas turbines and the one furthest from a satisfactory engineering solution is the rotor. A brief review of the current status and potential approaches applicable to automotive ceramic rotor technology is given. Since it is impossible to discuss the development of a ceramic gas turbine rotor without the main focus being on how to fabricate it, design and materials are briefly considered while fabrication procedures are emphasized. (auth)

5095 (ERDA—64, pp 199-205) **Application of programmable control system to 'baseline' gas turbine car for advanced combustor evaluation.** Dent, J.R. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A control system which combines the advantages of a digital program memory with an analog computing unit and working store was designed and tested. Standard signal conditioning (speed, temperature, position) and output circuits were provided, and diagrams of the system and typical installations are given. The computing element consists of a single operational amplifier of which the input, output, and gain are controlled by a digital program memory, continuously cycling through its program and re-sampling each input and updating each output every few milliseconds. (auth)

5096 (ERDA—64, pp 205-221) **Low cost automotive turbine wheel.** Allen, M.M. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A program was initiated to demonstrate the feasibility of using the Gatorizing forging process to produce low cost, wrought, integrally bladed turbines wheels and to continue the design development through the production stage. The first of two program phases, Phase I, demonstrated the feasibility of the forging method, generated initial design data, and produced a mass production cost estimate. In Phase II, the design details will be

further augmented and test prototypes will be produced. Selected results from Phase I and the status of Phase II are presented. (PMA)

5097 (ERDA—64, pp 221-225) **Evaluation of Gatorized/sup TM/ ceramic-wrought alloy attachment concepts.** Gilman, L. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

The status is reported of a program to develop and demonstrate the feasibility of a small turbine rotor using ceramic-wrought alloy attachment concepts. The Gatorizing process is used to forge a nickel base superalloy around the roots of ceramic blades. The attachment technique will be demonstrated by spin testing a ceramic bladed wrought alloy disk to 100 percent of design rpm at the then "state-of-the-art" temperature capability of spin pit technology. (auth)

5098 (ERDA—64, pp 226-242) **Advanced truck gas turbine system.** Kamo, R.; Balje, O.E. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

Although the outlook for high fuel economy and low cost for future ceramic turbines is very promising and development progress is encouraging, it appears that small gas turbine technology has progressed sufficiently for a competitive metal turbine to be developed. Criteria were developed to define the market requirements for over-the-road truck turbine engines in the 1980+ time frame;current truck turbine engines do not meet these criteria. Major problems with such engines, probable operating ranges of advanced turbines, and engine design features are summarized. (auth)

5099 (ERDA—64, pp 242-243) **Regenerator and recuperator.** Kormanyos, K.R. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A program was begun to evaluate ceramic recuperators as possible alternatives to regenerators in gas turbine engines. The evaluation is being made through mathematical analysis, sample fabrication, and testing. Efforts to date and future objectives are outlined. (PMA)

5100 (ERDA—64, pp 243-256) **Magnesium—aluminum—silicate heat exchanger development.** Kleiner, R.H. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A low expansion magnesium-aluminum-silicate (MAS) ceramic body (700 ppM up to 800°C) was developed. A versatile process for fabricating 28 inch diameter cores was also developed and was scaled up into a pilot plant. Much was learned about the mechanism of low thermal expansion in MAS, and the possibility of further reduction of the thermal expansion was shown. Initial laboratory tests on the chemical durability indicated that this MAS body is superior to lithium-aluminum-silicates (LAS) fabricated by conventional techniques. Progress is anticipated on improvements of matrix uniformity, additional characterization of the 700 to 800 ppM thermal expansion MAS matrix, engine test data, and on ceramic recuperator development. (auth)

5101 (ERDA—64, pp 256-257) **Glass-ceramic rotary regenerator core development.** Lanning, J.G. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A study was made of materials for rotary regenerator cores for automotive gas turbine engines, with emphasis on chemical durability problems. Four candidates were found which had acceptable sulfur and sodium resistance and which had the potential to operate successfully in a passenger car for 3500 hours. The thermal expansion, strain tolerance, and safety factor of core structures made from these materials are presented, and future program objectives are outlined. (PMA)

5102 (ERDA—64, pp 259-268) **Ceramic regenerator design and reliability program.** Rahnke, C.J. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

New ceramic materials were developed and screened for chemical resistance in accelerated engine tests, and full-size cores are being engine durability tested. Further improved materials and fabrication processes for better flow passage geometry are being developed, and these cores will be durability tested as they become available. Long range objectives of this program applying this new technology in advanced turbine and Stirling engines.

EXTERNAL COMBUSTION ENGINES

STIRLING CYCLE

5103 (ERDA—64, pp 295) **Introductory comments [on Stirling Engine Program].** Barber, K. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A program to develop an automotive Stirling engine was initiated. (PMA)

5104 (ERDA—64, pp 295-296) **History of the Stirling engine.** Postma, N. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

The history and the technological problems of Stirling engines are reviewed. Design difficulties include sealing problems, excessive weight and bulk, speed limitations, large radiator requirements, and high NO/sub x/ emissions. (PMA)

5105 (ERDA—64, pp 296-304) **Review of Ford/Philips program.** Postma, N. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

The objectives established for a program using a 1975 Ford Torino as a Baseline are discussed. Emission tests were conducted on the burner/heater head section of the Stirling Engine using the Federal Test Procedure, and emission levels were well below the objectives. Steady state fuel economy was determined in dynamometer tests, and the Stirling engine showed a 45 percent improvement over an internal combustion engine which was also tested. (PMA)

5106 (ERDA—64, pp 305-307) **Ford/ERDA program plans.** Postma, N. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

Long and short range planning are reviewed for a program to develop a Stirling engine for a subcompact vehicle. Efforts will include: (1) the testing of a Stirling engine; (2) the design of the vehicle to accommodate the engine; and (3) an analytical study of engine design and performance characteristics. (PMA)

RANKINE CYCLE

5107 (ERDA—64, pp 269) **Overview [on Rankine systems].** Luchter, S. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

An overview is given of a program to develop automotive Rankine cycle engines. Results indicate that a low emission steam car meeting the original 1976 levels is possible. Major emphasis has now shifted to fuel economy. (PMA)

5108 (ERDA—64, pp 269-286) **Water base reciprocating Rankine system program.** Demler, R. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A Rankine cycle engine was installed in a 1975 Dodge Monaco car, and seven hours of chassis dynamometer testing were completed. The results show that the automotive steam engine is capable of satisfying the following simultaneously: (1) very low emissions- without exhaust after treatment or efficiency compromise; (2) conservation of critical energy resources - as the steam engine can operate on fuels ranging from very low octane unleaded gasoline to synthetic fuels such as coal derived methanol;

and high fuel economy in the typical automobile duty cycle- approaching that of the diesel. (PMA)

5109 (ERDA—64, pp 286-294) **Status of organic Rankine technology.** Armstrong, J. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

An automotive powerplant using an organic Rankine cycle system was designed, built, and tested in a preprototype configuration. The total system was operated for about 150 hours under simulated driving conditions up to 70 mph. Packaging feasibility was demonstrated by installing the complete Rankine system mock-up in a 1972 Ford Galaxie and measuring adequate flow of ram cooling air through the condenser and engine compartment. This engine demonstrated emission levels well below 1978 Standards. Although the fuel economy is comparable to that of current internal combustion engines, improvements must be made to make it compatible with higher energy conservation standards. (auth)

ELECTRIC-POWERED SYSTEMS

5110 (ERDA—64, pp 385-397) **Impacts of electric car use in Los Angeles, St. Louis, and Philadelphia.** Hamilton, W. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A study was completed of energy, environmental, and socioeconomic impacts of electric car use in the Los Angeles region, and a similar study was begun for the St. Louis and Philadelphia regions. The applicability of electric cars to urban driving is surprisingly high, even with lead-acid batteries. Potential energy savings due to electric car use are not large, but petroleum savings in 1990 and 2000 can be important where coal-fired and nuclear powerplants provide recharge power. Air quality improvements due to electric car use are likely to be relatively modest owing to the major improvements in progress for conventional automobiles. Until battery depreciation costs are substantially reduced by advancing technology, electric cars will be at a substantial cost disadvantage relative to conventional subcompacts. Effects of electric car use on regional employment will be minor. (auth)

HYBRID SYSTEMS

5111 (ERDA—64, pp 61-77) **Organic Rankine bottoming cycle for long haul diesel trucks.** Patel, P. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

An organic Rankine cycle system using the exhaust energy from an internal combustion engine can improve fuel economy by 15 percent and can reduce exhaust emissions. Use in heavy-duty diesel trucks for long distance hauling is the most attractive application of this bottoming cycle. A schematic diagram and specifications of a prototype engine and its installation are given, and test results are presented. Fuel savings are compared with engine costs. (PMA)

VEHICLE DESIGN FACTORS

ENGINE-TRANSMISSION MATCHING

5112 (ERDA—64, pp 77-103) **Hydromechanical continuously variable transmission.** Young, F.M.; Huntley, P. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A program was begun to design, build, and test a hydromechanical transmission with a highly efficient, continuously variable speed ratio, which is independent of torque level. Phase I of the program, the design of the transmission, was essentially completed, and Phase II, the construction and testing of two prototype engines, was begun. Specifications, operation principles, and schematic diagrams of the prototype are presented. A computerized mathematical model was devised for simulated performance testing, and fuel consumption and exhaust emission characteristics were projected. (PMA)

ENGINE SYSTEM

5113 (UCRL—51923) **Thermal stress analysis of a ceramic gas-turbine stator blade.** Norris, D.M.; Grantham, P.V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Oct 1975. Contract W-7405-Eng-48. 34p. Dep. NTIS $4.00.

The thermal stress analysis of a ceramic gas turbine stator blade is reported. A three dimensional analysis, using finite element computer programs, first gives the temperature distribution from a sudden up-shock environment applied to the blade through experimentally determined convection boundary conditions. This time dependent temperature field is then used to calculate the stress state at discrete times for an appropriate boundary condition (constraint). The stress calculations indicate that peak stresses occur at about 4 seconds and are a result of incompatible bending and displacement between the three main components of the structure. Emphasis is placed on the general phenomenology of the deformation process through which the stresses are developed. (auth)

EMISSION CONTROL

HYDROCARBONS

5114 (BM-RI—8023) **Development and utility of reactivity scales from smog chamber data.** Dimitriades, B.; Sturm, G.P. Jr.; Wesson, T.C.; Sutterfield, F.D. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). 1975. 21p. Dep. NTIS $4.50.

The reactivities of 19 hydrocarbons known to be prominently present in automotive exhaust and ambient air were measured in a smog chamber. Results agreed well with those obtained using two other smog chambers. Reactivity scales were developed for hydrocarbons and aldehydes using the results of this work and those of a previous study. Application of the reactivity scales to automotive exhaust samples gave fair agreement between predicted and observed rate-of-NO_x-formation values; however, predicted and observed ozone yields were neither in agreement nor did they correlate well. This lack of correlation for ozone yield was attributed to the inappropriateness of: (1) the individual component reactivity data; (2) the reactivity classification scheme used; and (3) the linear summation method. In seeking to understand this problem and to develop more appropriate reactivity scales, the data were examined from a reaction mechanism standpoint, and further studies were suggested. (auth)

ALTERNATIVE FUELS

5115 (ERDA—64, pp 308) **Orientation and program plan.** Ecklund, E. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A program to investigate alternative automotive fuels is described. The program goal is to minimize and eventually eliminate petroleum as a highway vehicle fuel source, and candidates are considered for the short-term, mid-term, and long-term. (PMA)

5116 (ERDA—64, pp 308-311) **On-board hydrogen storage feasibility by methylcyclohexane method.** Sultan, O. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A study was made to evaluate a specific chemical approach for storing hydrogen as an automotive fuel. Methylcyclohexane (MCH) is transported to service stations and supplied to automobiles in a manner similar to gasoline. On demand, MCH is dehydrogenated (endothermic process) on-board the automobile and thus produces hydrogen. (auth)

5117 (ERDA—64, pp 311-323) **On-board hydrogen storage feasibility by metal hydride method.** Rohy, D.A. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A program was completed to investigate the use of metal hydrides for storage of hydrogen to be used as an automotive fuel. Hydrogen is stored in interstitial sites of the metal lattice with a hydrogen density greater than liquid hydrogen, and the hydriding and dehydriding can be performed indefinitely. Hydrogen storage

in metal hydrides was found to be a viable concept for automotive applications, and modified magnesium alloys were the best for this application among known alloys. Further work on reducing dissociation temperature remains to be done. (PMA)

5118 (ERDA—64, pp 323-328) **On-board hydrogen storage method by methanol-steam reforming method.** Kester, F.L. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A study was made of the feasibility of storing hydrogen fuels on automobiles in the form of a methanol and water mixture. Upon demand, the mixture is vaporized and catalytically reformed to produce hydrogen gas and carbon monoxide. The steam-reformation of tanked methanol was studied at 1 atm and 500 psi, and the system efficiency was analyzed. The feasibility was demonstrated, and recommendations for future research are presented. (PMA)

5119 (ERDA—64, pp 328-340) **Hydrogen enrichment.** Cotrill, H. (Jet Propulsion Lab., Pasadena, CA). 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

The concepts and status are reported of a program to develop an engine with improved fuel economy and significantly reduced emission levels. The basic concept is to add small amounts of hydrogen to allow the combustion of gasoline at ultra-lean conditions. The hydrogen used is generated on-board the vehicle by feeding gasoline and air to a hydrogen generator which produces hydrogen and carbon monoxide. The generated hydrogen-rich gas is mixed with gasoline and fed to the conventional engine in a continuous process requiring no storage of hydrogen on the vehicle. Engine generator tests demonstrated: (1) improved fuel economy; (2) the potential for NO/sub x/ emissions below 1978 Standards; and (3) the feasibility of HC and CO control by oxidation catalyst. Tests of the hydrogen/gasoline car demonstrated the potential of the concept to meet 1978 emission standards with improved fuel economy, and a compact generator with high performance was demonstrated. The next step is a road vehicle using hydrogen enrichment. (PMA)

5120 (ERDA—64, pp 340-343) **Technical survey of contemporary U.S. projects on hydrogen fueled I.C. engines.** Escher, W.J.D. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A survey was made to establish a data base from all of the current activities on hydrogen fueled engines in the U.S., regardless of the source of funding or organization doing the work. These are not coherent or coordinated programs, but many different programs with different objectives and different sources of funding. The fourteen organizations surveyed are listed along with the number of engines involved in each activity-a total of 38 engines. (auth)

5121 (ERDA—64, pp 344-345) **Methanol-gasoline fuels for automotive transportation.** Adt, R.R. (Univ. of Miami, FL). 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

An investigation was initiated with two primary objectives: (1) a study to summarize and evaluate studies concerned with the use of methanol and methanol-gasoline blends as fuels for automotive applications; and (2) experiments to characterize methanol-gasoline blends as an automotive fuel, focusing on characteristics lacking in the study. (auth)

5122 (ERDA—64, pp 345-356) **Characterization and research investigation of methanol and methyl fuels in automobile engines.** Adelman, H. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A program was initiated with the primary objective of making a characterization comparison of steady-state engine performance and emissions using: (1) gasoline; (2) methanol with rejetted carburetor and heated intake manifold; and (3) methanol with improved fuel-air induction systems (shock wave carburetion and fuel injection). The experimental engine, test equipment and instrumentation are still being installed. (auth)

5123 (ERDA—64, pp 356-368) **Experimental work with methanol/gasoline blends: a status report.** Hurn, R. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

Experimental work was begun to provide engineering data on the combustion characteristics and other physical properties of methanol-gasoline blends and to determine performance, fuel economy, and exhaust gas characteristics of blends used for automotive fuels. Test facilities and experiment plans are described, and some test results are reported. (PMA)

5124 (ERDA—64, pp 369-385) **Impacts of synthetic liquid fuel development for the automotive market.** Dickson, E.; Hughes, E.E. 1975.

From Automotive power systems contractors coordination meeting; Ann Arbor, Michigan, USA (6 May 1975).

In Automotive Power Systems contractors coordination meeting.

A study was made to put the impact of using synthetic fuels for automobiles, buses, and trucks into perspective, including deployment rates, inhibiting factors, and possible choices of fuels. Some of the key conclusions from the study are as follows: (1) all production options would have large environmental, social, and institutional impacts - especially in resource development regions; (2) no single option is best in all aspects, but net energy, impact, and compatibility analyses generally least favor methanol; (3) institutional and compatability considerations favor production of a synthetic crude oil rather than direct production of a consumer product; (4) because of compatability, methanol use is more likely in stationary than mobile applications (but this could release petroleum for automotive use); and (5) the return on investment and business risk climate require improvement before a private sector is likely. (auth)

MATERIALS

5125 (AERE-R—8070) **Fast ion conduction: a materials review.** McGeehin, P.; Hooper, A. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jul 1975. 33p. Dep. NTIS (US Sales Only) $5.00. UK pounds1.50.

A brief theoretical introduction to the important physical parameters involved in ionic conduction in solids is followed by order of magnitude estimates of these quantities for materials which can be considered as fast ion conductors. The major part of the review comprises a literature survey of materials which have been studied with a view to fast ion conduction. The significant physical characteristics of these materials are outlined, and conductivity and diffusion data reported where available. These data are coupled with additional technological criteria to indicate which classes of materials are considered worthy of further research. (auth)

5126 (COO—3342-4) **Low temperature and neutron physics studies. Progress report, September 1974—August 1975.** (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Physics). 19 Aug 1975. Contract E(11-1)-3342. 6p. Dep. NTIS $4.50.

Progress on and completion of various studies in solid state and neutron physics through use of neutron spectrometers is outlined. Topics discussed include: (a) characterization of the low temperature magnetization in the Cu(Fe) Kondo alloy, (b) study of the charge-density-wave phase transition in the superconductors $NbSe_3$ and $TaSe_3$, (c) neutron scattering by nuclearly polarized ^7Li, (d) extraneous scattering effects in the passage of polarized neutrons through high-field magnets, (e) preparation of neutron interferometer systems, and (f) revision of spectrometer facilities. (auth)

5127 (ORNL-TM—960) **Fuels and materials development program quarterly progress report for period ending September 30, 1964.** Patriarca, P. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Nov 1964. Contract W-7405-eng-26. 62p. Dep. NTIS $5.50.

The following are reported: fuel element development (deposition of UO_2 and W—Re, fabrication of Al-base fuel plates, H_2 sorption by Al, UC fabrication with fugitive sintering aids); nondestructive test development (electromagnetic, ultrasonic, penetrating-radiation); solid reaction studies (diffusion of ^{95}Nb into Ta monocrystals); and Zr metallurgy (Ti—Zr alloys, hydride precipitation in stressed Zircaloy-2, optical properties of Zr, preparation of monocrystals of Zr, zone refining of Zr, refractive

indices of anodized oxide films stripped from Zr). (6 tables, 10 fig) (DLC)

5128 (ORNL-TM—1000) **Fuels and materials development program quarterly progress report for period ending December 31, 1964.** Patriarca, P. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Feb 1965. Contract W-7405-eng-26. 90p. Dep. NTIS $6.00.

Reported are: fuel element development (CVD deposition of UO_2, W—Re, and doped W; fabrication of UC with fugitive sintering aids; fabrication of W—1 percent YAl_2 or $CeAl_2$); mechanical properties (ductility of irradiated Type 304 stainless steel, Cu, Fe, and Ni; tensile properties of irradiated Types 304, 302, and 316 stainless steel); nondestructive test development (electromagnetic, ultrasonic, penetrating-radiation); solid reaction studies (diffusion of ^{95}Nb and ^{182}Ta in Nb); and Zr metallurgy (anisotropy in Zircaloy 2, monocrystal preparation, zone refining, recrystallization structures). (DLC)

5129 (ORNL-TM—5029) **Fuels and materials development program quarterly progress report for period ending June 30, 1975.** Patriarca, P. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 40p. AT.

Advanced Absorber Materials: Thermal expansion of Eu_2O_3 was measured to 1500°C. Density variations in sintered Eu_2O_3 pellets were determined. Fabrication methods and thermal conductivity of Eu_2O_3—metal (W, Re) cermets were evaluated. Postirradiation examinations of europia pellets and pins are reported. Mechanical and Metallurgical Behavior of Weldments for LMFBR: 1200°F creep-rupture properties of Type 308 CRE stainless steel (ss) shielded metal-arc welds and elastic constant variations in Type 304—308 ss weldments are reported. Findings of the Task Force on Alternate Structural Materials for LMFBRs are summarized. Post-test examination of the Sodium Component Test Installation-Intermediate Heat Exchanger included the valves. (DLC)

5130 (RISO—302) **Kinematical model for the plastic deformation of face-centered cubic polycrystals.** Leffers, T. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan 1975. 114p. Dep. NTIS (US Sales Only) $6.50.

Thesis.

An attempt is made to explain how the continuity condition is fulfilled in face-centered cubic polycrystals. Early treatments were aimed directly at the formulation of a "dynamical theory, i.e. it was the intention to cover the magnitude of the stresses involved as well as the slip processes. These theories are described and shortcomings pointed out. It is argued that rolling texture is a good tool for a necessary intermediate stage of establishing a "kinematical" model describing the slip processes, but not the magnitude of the necessary stresses. It is demonstrated that the development of the rolling textures found experimentally in fcc materials can be computer-simulated on the basis of models for the plastic deformation that only involve (111) [110] slip; it is shown experimentally that the widely accepted twinning theory for the transition in fcc rolling texture does not reflect the behavior of real materials; and it is shown that the texture transition is thermally activated with an activation energy corresponding to that of cross slip. An electron-microscopical investigation of the slip process operating during rolling of fcc polycrystals is also included. On the basis of the computer simulation of the texture formation supplemented by the experimental results, a kinematical model is developed for the plastic deformation of fcc polycrystals by rolling and compared with earlier ones. In the proposed model the material continuity is maintained by inhomogeneous slip processes, combined with homogeneous multiple glide when the cross-slip frequency is high. (59 figures, 105 references) (auth)

5131 (SAND—75-5995) **Comments on "some thoughts on the material identification problem" by Karl S. Pister.** Herrmann, W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 7p. (CONF-751049—1). Dep. NTIS $4.50.

From Workshop on applied thermoviscoplasticity; Evanston, Illinois, USA (13 Oct 1975).

In the development of constitutive theory and its experimental validation, it is necessary that constitutive equations for viscoplasticity and the formulation of the initial boundary value problem representing the experiment be grounded in thermodynamics. Three methods are outlined for the solution of the material identification problem: material property measurements, iterative material coefficient fitting, and identification by numerical optimization. A modification and extension of the material identification procedure is proposed. (JSR)

5132 **Motion of a crack in an elastic solid subjected to general loading.** Freund, L.B. (Brown Univ., Providence). pp 553-562 of In Dynamic crack propagation. Sih, G.C. (ed.). Leiden; Noordhoff International Publishing (1973).

From International conference on dynamic crack propagation; Bethlehem, Pennsylvania, USA (9 Jul 1972).

See CONF-720709—.

The mode I extension of a plane crack in an elastic solid is discussed. The solid is subjected to general time-independent loading and the crack is assumed to extend in its own plane from an initial equilibrium position. The solutions of problems for two particular crack tip motions are first discussed. In the first of these, the crack tip suddenly begins to move at a constant speed and continues to move at that speed for all time. The second problem is the same as the first except that at a certain instant the crack tip suddenly stops. The complete elastic stress wave solution can be found for each of these problems. Certain features of the solutions of these problems are exploited to construct the exact stress intensity factor for arbitrary, nonuniform extension of the crack tip. An energy balance fracture criterion is then imposed to determine an equation of motion for the crack tip, which takes the form of a first-order ordinary differential equation governing the amount of extension as a function of time. Features of the equation of motion such as the fact that a constant specific fracture energy predicts a terminal crack velocity equal to the Rayleigh wave speed are discussed. Speculative remarks are made on variations of specific fracture energy with crack tip speed which predict more realistic values of terminal velocities. (auth)

5133 **Roughness characterization of smooth machined surfaces by light scattering.** Stover, J.C. (Dow Chemical, Golden, CO). *Appl. Opt.*; **14**: No. 8, 1796-1802(Aug 1975).

Characterization of surface roughness was generally limited to rms deviation from the mean and occasionally the autocorrelation length. By considering the surface to be a superposition of many sinusoidal gratings, the surface spectral density function (SDF) was calculated from measurements of the light scattered out of a reflected He—Ne laser beam. By rotating the sample, the SDF can be found for anisotropic surfaces (such as machined surfaces). The SDF allows examination of roughness as a function of spatial frequency, which is important for many applications. Interferometric and scattering results are compared for a rough (350-A rms) machined surface, and finally a smooth (50-A rms) diamond machined surface is characterized. (auth)

METALS AND ALLOYS

5134 (RDT-M—4-1T(8-75)) **Carbon steel castings. (ASME SA-216 with additional requirements).** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Research and Development). Aug 1975. RSO.

5135 **COMBUSTION MODELING: URBAN AND WILDLAND FIRES. 1974 FALL MEETING OF THE WESTERN STATES SECTION/THE COMBUSTION INSTITUTE, NORTHRIDGE, CALIFORNIA, OCTOBER 21—22, 1974.** Northridge, CA; United States of America (USA); Western States Section/The Combustion Institute (1974). vp. (CONF-741049—). $25.00.

From Meeting of the Western States Section;The Combustion Institute; Northridge, California, USA (21 Oct 1974).

Nineteen of the papers presented at the conference are compiled. Separate abstracts were prepared for two papers and ten papers were processed for inclusion in ERDA's energy data bases. (JSR)

PREPARATION AND FABRICATION

5136 (CONF-750866—1) **Study of the kinetics of copper cementation by metallic nickel.** Miller, R.L.; Wadsworth, M.E. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA); Utah Univ., Salt Lake City (USA)). 1975. 24p. Dep. NTIS $4.50.

From Proceedings of the Canadian Institute of Mining and Metallurgy; Edmonton, Canada (25 Aug 1975).

The kinetics of cementation of copper by nickel from acidified solution of copper sulfate were found to follow a pseudo first-order-rate with respect to copper concentration, over the temperature range studied. An Arrhenius plot of the temperature/rate-constant data was nonlinear. From this nonlinearity, the inference was that the overall reaction was controlled by a different mechanism at higher temperatures than at lower temperatures. The temperature/rate-constant data were analyzed using a nonlinear-curve-fitting computer program. These analyses yielded an activation energy of about 3,700 cal/mole in the high temperature range and about 19,500 cal/mole in the low temperature range. The high temperature activation energy results are consistent with those for reaction control by diffusion of copper ion through a solution boundary layer. The activation energy for the low temperature range is consistent with that for reaction control by a chemical

process. The dehydration of the hexaaquo copper II complex is a possible ratelcontrolling step. Both mechanisms control the overall reaction at intermediate temperatures. A thermodynamic analysis of the overall reaction indicates that any reasonable concentration of nickel ion would have no effect on the reaction. A physical and chemical description of the cementation reaction and product was obtained: At high temperatures a friable, encapsulating crust forms around the substrate nickel. At low temperatures, the crust was less friable but still sufficiently porous to permit continuing reaction between the copper and nickel. The crust had a tendency to entrap nickel solution with the result that analyses of nickel concentration in the bulk solution were inconsistent. Energy dispersive x-ray analysis of the cement copper failed to reveal the presence of nickel. From these results, the conclusion was reached that a copper-nickel alloy did not form during the cementation reaction. (auth)

5137 (CONF-750968—2) **Target preparations and thickness measurements.** Adair, H.L.; Kobisk, E.H. (Oak Ridge National Lab., Tenn. (USA)). 1975. 41p. Dep. NTIS $5.00.

From 4. annual international conference of the Nuclear Target Development Society; Argonne, Illinois, USA (29 Sep 1975).

A wide variety of isotope target preparative methods have been used, including rolling of metals, vapor deposition, electrodeposition, chemical vapor deposition, and sputtering, to obtain thin and thick films of most elements or compounds of elements in the Periodic Table. Most thin films prepared for use in self-supported form as well as those deposited on substrates require thickness measurement (atom count and distribution) and/or thickness uniformity determination before being used in nuclear research. Preparative methods are described together with thickness and uniformity determination procedures applicable to samples being prepared (in situ) and to completed samples. Only nondestructive methods are considered applicable to target samples prepared by the ORNL Solid State Division, Isotope Research Materials Laboratory. Thickness or areal density measurements of sufficient sophistication to yield errors of less than +-1 percent have been achieved with regularity. A statistical analysis procedure is applied which avoids error caused by balance zero-point drift in direct weight measurement methods. (auth)

5138 (CONF-751012—6) **Development of automated pipe and tube welding techniques for aluminum.** Edmonds, D.P.; Goodwin, G.M.; Slaughter, G.M. (Oak Ridge National Lab., Tenn. (USA)). 1975. 11p. Dep. NTIS $4.00.

From SME;ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

Automated orbital welding techniques were applied to Al alloy 3003 pipe and tubing, and considerable savings of money and time were achieved. (DLC)

5139 (CONF-751012—7) **Advances in stainless steel welding for elevated temperature service.** Goodwin, G.M.; Cole, N.C.; King, R.T.; Slaughter, G.M. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. 11p. Dep. NTIS $4.00.

From SME;ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

An extensive program to characterize the microstructures and determine the mechanical properties of stainless steel welds is described. The amount, size, shape, and general distribution of ferrite in the weld metal was studied. The effects of electrode coatings on creep-rupture properties were determined as were the influences of slight differences in analyzed contents of carbon, silicon, phosphorus, sulfur, and boron. Using the above information, a superior commercially produced electrode was formulated which took advantage of chemical control over boron, titanium, and phosphorus. This electrode produced deposits exhibiting superior mechanical properties and it was successfully utilized to fabricate a large nuclear reactor vessel. (auth)

5140 (CONF-751012—9) **Mechanized welding in a glove box.** Pugacz, M.A.; Walker, D.E. (Argonne National Lab., Ill. (USA)). Oct 1975. Contract W-31-109-Eng-38. 6p. Dep. NTIS $4.50.

From SME;ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

An orbital-tungsten-arc welding gun was installed in a helium glove box to automatically weld final end closures to capsules that were to contain an atmosphere of required composition and quality. A fixture, tooling, and procedures were developed to automatically position the tungsten electrode repetitively with respect to the end of the tube to be welded closed. (auth)

5141 (LYCEN—75-05) **Epitaxial growth of thin single-crystals and their quality study by Rutherford scattering in channeling conditions.** Kirsch, R. (Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire; Lyon-1 Univ., 69 (France)). 1975. 63p. (In French). INIS.

Some aspects of thin crystalline layers are reminded: vacuum deposition, epitaxial growth, annealing and interdiffusion ion channeling and scattering of 1-2 MeV helium ions are used to study the crystalline quality, the annealing effects and in some cases the interdiffusion in epitaxial multilayers of silver, copper, gold, and nickel. Thin single-crystals of gold and nickel oriented (III) plan parallel to the surface were obtained by successive epitaxial growth from muscovite mica clivages. The mounting techniques of single crystal, self-supporting, 300 to 1200 Angstroems thick, gold and nickel targets of 3 mm dia are described. The gold single-crystals have dislocation densities of 10^8 cm^{-2} and the various epitaxial layers are obtained without twinning. (FR)

5142 (ORNL-TM—5163) **Behavior and properties of welded transition joints between austenitic stainless steels and ferritic steels: a literature review.** King, J.F. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 16p. AT.

Concerns and failures associated with dissimilar-metal transition joints in a nuclear system such as the LMFBR have been sufficient to prompt several investigations of the problem over the last two to three decades. A review of the literature shows that the generally accepted method of making transition joints between austenitic and ferritic steels for high-temperature cyclic service is to use nickel-base filler metals. Despite the apparent satisfactory histories of transition joints welded in this manner, a reasonable doubt remains about the appropriate design criteria and fabrication procedures for a welded joint that will reliably operate for a lifetime of 300,000 h. (16 references) (DLC)

5143 (RFP—2233) **Characterization of brazing alloys with stainless steels.** Riefenberg, D.H.; Doyle, J.H.; Hillyer, R.F.; Bennett, W.S. (Atomics International Div., Golden, Colo. (USA)). 19 Sep 1975. Contract E(29-2)-3533. 30p. Dep. NTIS $4.00.

To simulate braze joints, qualitative x-ray mapping of the elemental interactions between brazing alloys and two common types of stainless steels was performed via the electron microprobe. In general both steels, Types 304L and 21-6-9, react with a particular brazing alloy in a similar manner, the exceptions being the gold—copper brazing alloys which show deeper penetration into the 21-6-9 stainless steel. (26 figures) (auth)

5144 (UCRL—51916) **Diamond-turning HP-21 beryllium to achieve an optical surface.** Allen, D.K.; Hauschildt, H.W.; Bryan, J.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Sep 1975. Contract W-7405-Eng-48. 62p. Dep. NTIS $5.45.

Investigation of diamond turning on beryllium was made in anticipation of obtaining an optical finish. Although results of past experiences were poor, it was decided to continue diamond turning on beryllium beyond initial failures. By changing speed and using coolant, partial success was achieved. Tool wear was the major problem. Tests were made to establish and plot wear as a function of cutting speed and time. Slower speeds did cause lower wear rates, but at no time did wear reach an acceptable level. The machine, tools, and procedure used were chosen based on the results of preliminary attempts and on previous experience. It was unnecessary to use an air-bearing spindle because tool failure governed the best finish that could be expected. All tools of diamond composition, whether single crystal or polycrystalline, wore at unacceptable rates. Based on present technology, it must be concluded that beryllium cannot be feasibly diamond turned to achieve an optical finish. (22 fig.) (auth)

5145 (Y-DA—6352) **Electron-beam filament specification and gun contours.** Scott, D.G. (Oak Ridge Y-12 Plant, Tenn. (USA)). 5 Nov 1975. Contract W-7405-eng-26. 7p. (CONF-751012—11). Dep. NTIS $4.50.

From SME;ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

In making precision, partial-penetration, electron-beam welds, large variations in the welds were noticed between filament changes. Careful dimensional checking of filaments and grid cups revealed that much of the problem is caused by variations in the grid-cup contour. To ensure repeatability of welds, a specification has been written for the purchase of filaments, and grid cups are characterized dimensionally. For a given procedure, grid cups are selected on the basis of dimensions and checked for reproducibility on test welds before being assigned to production. (auth)

5146 (Y-DA—6354) **Joint design for welding thin materials.** Scott, D.G. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1975. Contract W-7405-eng-26. 9p. Dep. NTIS $4.50.

Techniques were developed for making leak-tight welds in 0.254-to-0.508-mm-thick Type 304L stainless steel or other sheet-metal containers. Inexpensive sheet-metal forming equipment is used to obtain a tight-fitting lap joint which makes a gas tungsten-arc weld possible without the aid of backing materials. Techniques

used in making a butt weld in 0.254-to-0.508-mm-thick material for enclosure of thick metal parts were also developed. (auth)

5147 (Y-OA—1550) **Cold welding of aluminum tubing.** Irons, J.L. (Oak Ridge Y-12 Plant, Tenn. (USA)). 3 Nov 1975. Contract W-7405-eng-26. 7p. (CONF-751012—12). Dep. NTIS $4.50.

From SME;ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

Cold welding of aluminum tubing is accomplished by applying pressure to radiused anvils from both sides of the cross section to be welded. The portion of the tube being welded is restrained within the fixture during the welding operation to limit diameter changes. The cold welding method produces a highly reliable metallurgically bonded joint and is adaptable to most tubing closure applications, where accessibility is provided for welding tooling. (auth)

5148 (UCRL-Trans—10518) **Process for producing shiny surfaces on objects made of aluminum and aluminum alloys.** Vernet, A. Feb 1971. Translated by R. Dewar from a German Patent 804 054. 5p. Dep. NTIS $4.50.

The shiny surfaces may be produced by immersing the object in an acid bath containing a metal salt that acts as a catalyst. Such a bath may comprise 50 percent phosphoric acid, 6.5 percent nitric acid, 6 percent acetic acid, 25 percent sulfuric acid, 12.5 percent water, and 3 percent nickel nitrate. A Co, Cu, Zn, Cr, or Al salt may be substituted for the Ni salt, and the object can be made the anode if an electric current is used. (DLC)

5149 Preparation of thin actinide metal disks using a multiple disk casting technique. Conner, W.V. (Dow Chemical U.S.A., Golden, CO). *J. Less-Common Met.*; **42**: No. 3, 303-310(Oct 1975).

A casting technique has been developed for preparing multiple actinide metal disks which have a minimum thickness of 0.006 inch. This technique was based on an injection casting procedure which utilizes the weight of a tantalum metal rod to force the molten metal into the mold cavity. Using the proper mold design and casting parameters, it has been possible to prepare ten 1/2-inch diameter neptunium or plutonium metal disks in a single casting. This casting technique is capable of producing disks which are very uniform. The average thickness of the disks from a typical casting will vary no more than 0.001 inch and the variation in the thickness of the individual disks will range from 0.0001 to 0.0005 inch. (auth)

5150 Powder approach for multifilamentary niobium-tin superconducting wire. Hemachalam, K.; Pickus, M.R. (Inorganic Materials Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Appl. Phys. Lett.*; **27**: No. 10, 570-571(15 Nov 1975).

Based on powder-metallurgy techniques, a process to fabricate Nb_3Sn multifilamentary superconducting wire is described. The current-carrying capacity of the wire was above 10^5 A/cm² at a steady transverse magnetic field of 50 kG and about 10^5 A/cm² at 100 kG.

STRUCTURE AND PHASE STUDIES

5151 (ORNL—5050, pp 70-71) **Actinide oxides, nitrides, and carbides.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

In compatibility studies, the possibility of q forming Laves-phase compounds with uranium (A component) and combinations of chromium with iron or nickel (B component) was investigated. Results confirm that compounds of the type U(Fe/sub x/Cr/sub 1-x/)$_2$ do exist and that they have the C15 Laves-phase structure. (LK)

5152 Growth of gold thin film dendrites on graphite substrates. Darby, T.P.; Wayman, C.M. (Univ. of Illinois, Urbana). *J. Cryst. Growth*; **29**: 98-108(1975).

Dendritic particles found in thin films of gold, vapor deposited on vacuum-cleaved graphite crystals at substrate temperatures of 100°C or lower, were examined using electron microscopy and diffraction. Two types of dendrites could be distinguished on the basis of their branch geometries and directions. Other observations were made and considered, and include which double position orientation a given branch assumes, transitions from one branch type to the other, variations in branch morphology with changes in local particle density, and preferential nucleation and growth from heterogeneities in the substrate. A model based on interface stability and whether the particles are growing in a two- or three-dimensional manner is described which explains the general results. (11 fig) (auth)

5153 Thermodynamic study of phase stability in the thorium—copper equilibrium system. Bailey, D.M. Ames, IA; Iowa State Univ. (1975). 42p. University Microfilms Order No. 75-17,378.

Thesis (Ph. D.).

The thermodynamics of formation of the four intermediate phases in the thorium—copper equilibrium system were evaluated from electromotive force data obtained from solid state electrochemical cells with a calcium fluoride electrolyte. The free energies and enthalpies of formation are essentially constant, in units of kcal/g-atom Th, for the thorium-poor phases in this system, a feature shared with the Th—Fe, Th—Co, and Th—Ni systems. The trend in the magnitude of the enthalpy of formation of the thorium-poor phases in the Th—Fe, Th—Co, Th—Ni, and Th—Zn systems is in accord with the bonding energies for the d/sup n-2/ sp valence states for the respective transition metals (and for zinc): the value for the Th—Cu system is lower, corresponding more closely to the bonding energy of the monovalent $d^{10}s$ state for copper. (Diss. Abstr. Int., B)

5154 Thermodynamics of thermoelastic martensitic transformations. Tong, H.C.; Wayman, C.M. (Univ. of Illinois, Urbana). *Acta Metall.*; **23**: 209-215(Feb 1975).

A thermodynamic study of thermoelastic martensites was made with particular reference to some experimental results previously obtained for iron-platinum alloys. The effect of parent phase ordering in depressing the T_o temperature was satisfactorily explained using a quasichemical approach and a consequent difference in bonding enthalpies. The transformation latent heat was determined by calorimetry for the parent-martensite transformation in both ordered and disordered Fe-Pt alloys. For transformation in the ordered alloy, the latent heat ΔQ is much smaller (83 cal/mole) than that for the corresponding disordered alloy (570 cal/mole). These measurements implement the quasichemical interpretation. Other results of general applicability were also obtained. The stored non-chemical free energy difference $\Delta\epsilon$/sub nc/ is analytically expressed in terms of the characteristic temperatures T_o and T_o', and the transformation latent heat ΔQ. It is indicated that the separation of T_o' from T_o is directly proportional to the value of $\Delta\epsilon$/sub nc/. The quantity $(T_o - T_o')/T_o$ is seen to provide a reasonable estimate of the ratio $\Delta\epsilon$/sub nc//ΔQ. Following a statistical expression for the free energy, a simple development enables the calculation of the Debye temperature of the martensite, and a comparison of the parent phase and martensite Debye temperature is made. (auth)

5155 Electron correlations at metallic densities. Lowy, D.N.; Brown, G.E. (State Univ. of New York, Stony Brook). *Phys. Rev., B;* **12**: No. 6, 2138-2149(15 Sep 1975).

The effect of correlations on effective interactions in the electron gas is studied. It is argued that because of the strong correlations at short distances, two-body terms make up the dominant contribution to this effective electron-electron interaction for small separations. An interpolated effective electron-electron interaction is proposed which is approximately correct for all separations. This interaction incorporates both the two-body short-distance correlation effects, and the well-known many-body collective behavior at large separations. A number of metallic properties including cohesive energies and plasmon dispersion curves are calculated using this effective interaction, and all are found to be in agreement with the results of Singwi, Tosi, Land, and Sjoelander who calculated the effects of the short-distance correlations using a different method. (auth)

MECHANICAL PROPERTIES

5156 (CEA-N—1796) **TEDEL programme, notice of the plasticity section.** Hoffmann, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). May 1975. 17p. (In French). INIS.

First supplement to the CEA-N--1751 report.

A plasticity model was introduced and is now operational in the TEDEL programme (piping and framework). At the moment it allows for either regular loading or cyclic loading under isotropic hardening conditions. The dynamic module allows the study of dynamic-plastic problems (such as accidents on a piping system). It can accept several types of material characterized by traction curves which may be of any form. Instructions are also given for the use of a new option (variable) by which the displacement values laid down for different load situations may be modified. (FR)

5157 (CONF-750574—1) **Heat treatment versus properties studies associated with the Inconel 718 PBF acoustic filters.** Smolik, G.R.; Reuter, W.G. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 24 Feb 1975. 82p. Dep. NTIS $5.50.

From AIME metallurgical society; Toronto, Ontario, Canada (May 1975).

PBF acoustic filter Unit No. 1 cracked when heat treatment was attempted. The effects of prior thermal cycling, solution anneal temperature, and cooling rate from solution anneals were investigated. The investigations concerned influences of the above variables upon both 1400°F stress rupture solution-annealed properties and room temperature age-hardened properties. 1400°F stress rupture properties were of interest to assist the prevention of cracking during heat treatments. Room temperature age-hardened properties were needed to ensure that design requirement would be provided. Prior thermal cycling was investigated to determine if extra thermal cycles would be detrimental to the repaired filter. Slow furnace cools were considered as a means of reducing thermal stresses. Effects of solution annealing at 2000 and 1900°F were also determined. Test results showed that slow cooling rates would not only reduce thermal stresses but also improve 1400°F ductility. A modified aging treatment was established which provided the required 145 ksi room temperature yield strength for the slowly cooled material. Prior cooling did not degrade final age-hardened room temperature tensile or impact properties. (auth)

5158 (COO—1676-37) **Hydrogen strengthening in niobium and niobium-base alloys.** Sagues, A.A.; Ulitchny, M.G.; Gibala, R. (Case Western Reserve Univ., Cleveland, Ohio (USA). Dept. of Metallurgy and Materials Science). 1975. Contract AT(11-1)-1676. 15p. (CONF-750925—7). Dep. NTIS $4.50.

From Conference on effects of hydrogen on behavior of materials; Jackson, Wyoming, USA (7 Sep 1975).

This paper discusses solid-solution hardening, precipitate hardening, and alloy softening for Nb and Nb-base interstitial alloys. The effects of these strengthening mechanisms on strain rate sensitivity and ductility are also examined. It is shown that all three strengthening effects involve mainly interaction of dislocations with mobile hydrogen defects and are influenced or caused by residual interstitial solutes. (DLC)

5159 (COO—2172-5) **Mechanical properties and mechanical equation of state of 1100 aluminum alloy in monotonic loading.** Ellis, F.V.; Wire, G.L.; Li, C.Y. (Cornell Univ., Ithaca, N.Y. (USA). Dept. of Materials Science and Engineering). 1975. 41p. Dep. NTIS $5.00.

Load relaxation experiments are performed on 1100 aluminum alloy as a function of temperature. Based on the experimental results, the behavior of the mechanical equation of state for plastic deformation including the contribution of grain boundary sliding is established. Attempts are made to apply the approach of mechanical equation of state to predict the creep properties of this alloy. (auth)

5160 (COO—2172-11) **Grain boundary sliding and structure. Progress report, December 1, 1974—November 30, 1975.** Li, C.Y. (Cornell Univ., Ithaca, N.Y. (USA). Dept. of Materials Science and Engineering). 1 Sep 1975. Contract E(11-1)-2172. 28p. Dep. NTIS $5.00.

Load relaxation experiments were performed in the region where the grain matrix plastic deformation is important on type 316 stainless steel and a zircaloy specimen, and the data are being analyzed. Anelastic deformation in pure aluminum was investigated. A dislocation glide-controlled anelastic component is identified which may be governed by the same laws as those for plastic deformation at low temperature and/or high plastic strain rate. The investigation of grain boundary sliding in type 316 stainless steel is being continued. Experimental data without the influence of thermal aging are successfully obtained. Load relaxation data on single crystal and polycrystal nickel specimens show that the constant hardness curves of these specimens belong to two different families. The growth of the grain boundary cavity under applied stress and irradiation has been analyzed. It is found that the normal stress at the grain boundary which is the driving force for atomic transport controlled cavity growth can be relaxed by grain boundary sliding. (auth)

5161 (COO—3084-38) **Combined macroscopic and microscopic approach to the fracture of metals, period July 1974—June 1975. Technical progress report No. 38.** Gurland, J.; Rice, J.R. (Brown Univ., Providence, R.I. (USA)). Jul 1975. Contract E(11-1)-3084. 14p. Dep. NTIS $4.50.

During the report period major studies have been completed on (1) the microscale fracture conditions for the brittle and ductile fracture initiation modes at a macroscopic crack tip, (2) the formulation of dilational plasticity constitutive relations for void containing materials as applied to the inception of ductile rupture, (3) cavity growth during diffusive rupture processes as encountered in creep rupture at low stress but high temperature, and (4) particle and boundary strengthening mechanisms in carbon steels. In addition, work has continued on crack tip modeling by finite elements and mechanisms of ductile void growth near a crack tip. (auth)

5162 (HEDL-SA—925) **Some questions regarding the interaction of creep and fatigue.** James, L.A. (Westinghouse Hanford Co., Richland, Wash. (USA)). Apr 1975. Contract AT(45-1)-2170. 20p. (CONF-751106—2). Dep. NTIS $4.50.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

Data are presented from fatigue-crack growth tests conducted on Type 304 S.S. in inert environments at elevated temperatures which show that the thermal-activation noted in similar tests run in air environments is not present in the inert environment. Similar observations from the literature are reviewed, including the observation that the time-dependency noted in tests conducted in elevated temperature air environments is also greatly suppressed in inert environments. These findings suggest that an interaction between the fatigue process and the corrosive air environments is responsible for the thermally activated time-dependent behavior often attributed to creep-fatigue interaction. Data are also presented which show that the fatigue-crack growth behavior of Type 304 S.S. subjected to significant creep damage prior to fatigue testing does not differ appreciably from the behavior of material not subjected to prior creep damage, again indicating minimal interaction between creep and fatigue. It is suggested that in the temperature range where pressure vessels and piping are generally designed to operate (i.e. below about one-half the absolute melting temperature of the alloy), the interaction between creep and fatigue is far less significant than once supposed, and that the major parameter interacting with the fatigue process is that of high-temperature corrosion. (39 references, 12 fig) (auth)

5163 (HEDL-TME—75-80) **Fatigue-crack propagation behavior of Inconel 718.** James, L.A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. Contract AT(45-1)-2170. 63p. Dep. NTIS $4.25.

The techniques of linear-elastic fracture mechanics were used to characterize the effect of several variables (temperature, environment, cyclic frequency, stress ratio, and heat-treatment variations) upon the fatigue-crack growth behavior of Inconel 718 base metal and weldments. Relevant crack growth data on this alloy from other laboratories is also presented. (33 fig, 39 references) (auth)

5164 (NMI—7020-2) **Effect of heat treatment on the properties of high-uranium alloys.** Anderson, R.W. (Nuclear Metals, Inc., Concord, Mass. (USA)). 27 Mar 1964. 52p. Dep. NTIS $5.50.

Declassified 29 Nov 1973.

Effects of various heat treatments on the hot-hardness and microstructure of three high-uranium alloys were studied to aid in the specification of the composition and thermal history of fuels capable of improved irradiation behavior. It was found that the alloy additions (up to 350 ppM Fe, Si, and Al) cause a precipitation hardening system; that is, the alloy additions can be taken into solution at high temperatures and then precipitated as fine particles at lower temperatures. Hot-hardness and metallographic data were obtained concerning the effects of solution temperatures, quenching rates from solution temperatures, and time-temperature relationships necessary for precipitation of the alloy phases. 25 fig. (auth)

5165 (ORNL—5088) **Investigation of alloying effects in aluminum dispersion strengthened with Al_2O_3.** Copeland, G.L. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 112p. Dep. NTIS $5.45.

Two types of alloying elements were investigated to determine if the room-temperature strength could be improved and if, through lowering the oxide content, the high-temperature ductility could be improved. Mg was investigated for its solid solution strengthening in one type alloy. The other type alloy involved further dispersion strengthening through adding Fe, Mo, Zr, Cr, V, and Ti which form highly stable intermetallic compounds with Al. Fabrication techniques were developed which produced uniform and reproducible rods for testing. Prealloyed powders were produced by atomizing the molten alloys and collecting the powders in water. This procedure produced uniform powders with a very fine distribution of the intermetallic compounds. Fabrication into rods then included ball-milling, vacuum hot pressing, vacuum heat treating, and hot extrusion. Mg additions improved strengths up to 200°C with little effect above that temperature. Room-temperature tensile strengths up to 77,000 psi were obtained which are comparable to the strengths obtained in conventional aluminum alloys. The additional dispersion strengthening of the intermetallic compounds is additive to that of the oxide from room temperature to 450°C. No significant improvements in ductility are obtained by reducing the oxide content since even at very low ball-milling times (i.e., low oxide contents) the uniform elongation at 450°C is typically 0.5 percent. Good combinations of strength and ductility at 450°C were obtained in some of the alloys containing

intermetallic compounds with no ball-milling. Typical properties at this temperature were tensile strengths of 7,000 psi, uniform elongation of 3 percent, and total elongation of 35 percent. (21 tables, 33 fig, 43 references) (auth)

5166 (ORNL-TM—5110) **Candidate creep-recovery model for 2 1/4 Cr—1 Mo steel and its experimental implementation.** Robinson, D.N. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 20p. AT.

A uniaxial, creep-recovery model due to R. Lagneborg is recast into a form which facilitates its implementation through a testing program which is entirely phenomenological. The model is being considered under the High-Temperature Structural Design Program at ORNL as a candidate model for $2^1/_4$ Cr—1 Mo steel at high temperature. A specific experimental program is proposed for the determination of the several material parameters of the model. Generalization of the uniaxial formulation to that for general states of stress is briefly discussed. (auth)

5167 (SAND—75-0362) **Short-time, high temperature mechanical testing of electrically conductive materials.** Marion, R.H.; Karnes, C.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 51p. Dep. NTIS $5.45.

Design and performance details are given for a facility which was developed to obtain the mechanical properties of materials under high heating rate or transient temperature conditions and medium strain rates. The system is shown to be applicable to materials possessing electrical resistivities ranging from that of aluminum to that of graphite without taxing the heating capability. Heating rates as high as 2000°K/s in graphite are attained under controlled conditions. Methods of measuring temperature and the effects of expected temperature distributions are discussed. A method for measuring strain valid for transient temperature conditions to 3000°K is described. Results are presented for the stress-strain behavior of 316 stainless steel and ATJ(S) graphite obtained for heating times of a few seconds. (auth)

5168 (SAND—75-5696) **Notch constraint effects on the dynamic fracture toughness of an unaged beta titanium alloy.** Rack, H.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 18p. Dep. NTIS $4.50.

The influence of notch included angle and root radius on the apparent dynamic fracture toughness of an unaged metastable beta titanium alloy, Ti—3Al—8V—6Cr—4Zr—4Mo, has been examined. The apparent fracture toughness, K/sub Id/(rho), increases with both notch radius, rho and included angle, ω. These results have been compared with the theoretical predictions of Tetelman, et al. and Smith. The comparisons show that neither theory accurately describes the effect of varying notch constraint on the apparent dynamic fracture toughness. Although preliminary considerations indicate that qualitative descriptions of notch acuity effects may be given by recent finite element analysis of the stress and strain distributions below a notch root, there is presently no quantitative basis for determining the true dynamic fracture toughness of materials from the results of blunt notch experiments. (auth)

5169 DYNAMIC CRACK PROPAGATION. PROCEEDINGS OF AN INTERNATIONAL CONFERENCE, BETHLEHEM, PA, JULY 10—12, 1972. Sih, G.C. (ed.). Leiden; Netherlands; Noordhoff International Publishing (1973). 733p. (CONF-720709—).

From International conference on dynamic crack propagation; Bethlehem, Pennsylvania, USA (9 Jul 1972).

Papers presented at the conference are concerned with micro-fracture, brittle materials and glass, ductile materials, dynamic crack models, continuum experiments, analytical crack problems, and structures. A separate abstract was prepared for each of five papers. One item has been announced in Nuclear Science Abstracts and the five items have been announced in ERDA Research Abstracts. (JRD)

5170 Void growth during spall fracture of aluminum monocrystals. Stevens, A.L.; Davison, L.; Warren, W.E. (Sandia Labs., Albuquerque, NM). pp 37-48 of In Dynamic crack propagation. Sih, G.C. (ed.). Leiden; Noordhoff International Publishing (1973).

From International conference on dynamic crack propagation; Bethlehem, Pennsylvania, USA (9 Jul 1972).

See CONF-720709—.

High-purity monocrystalline aluminium disks of three crystallographic orientations were subjected to carefully controlled planar impact producing low levels of spall damage. This damage was observed to consist of voids of essentially octahedral form having (111) planes as faces. To describe the growth of these voids a kinematical model based on the motion of edge dislocations is proposed. Dynamical equations describing the rate of growth of an individual void are obtained by applying established concepts of dislocation mechanics to the kinematical model. (auth)

5171 Dynamics of crack propagation in double cantilever beam specimens. Bilek, Z.J.; Burns, S.J. (Brown Univ., Providence). pp 371-385 of In Dynamic crack propagation. Sih, G.C. (ed.). Leiden; Noordhoff International Publishing (1973).

From International conference on dynamic crack propagation; Bethlehem, Pennsylvania, USA (9 Jul 1972).

See CONF-720709—.

The dynamics of crack propagation in double cantilever beam specimens with various end loading conditions was solved analytically, including wave effects, within the limits of Bernoulli-Euler beam theory. Hamilton's equation as applied to the reversible and non-reversible fracture surface energy and the beam's strain energy and kinetic energy gives a critical bending moment that moves with the crack tip. This critical bending moment is the fracture criterion. The magnitude of the critical bending moment may be dependent on the crack velocity. The crack length vs. time relation of different fracture surface energies is tractable from solutions of Bernoulli-Euler beam theory for constant tip end loadings with a bending moment, a displacement rate or a force. The surface energy for the specific examples of constant bending moment or constant displacement rate is a unique function of the crack length divided by the square root of the time of fracture. Thus dynamic fracture surface energies, or equivalent dynamic stress intensity factors, may be deduced from the time dependence of the crack length. The crack velocity varies continuously during crack propagation, permitting the surface energy to be recorded as a function of the crack velocity. Examples of strain rate independent and strain rate dependent fracture surface energies will be presented for the example of constant displacement rate loading. (auth)

5172 Torsional wave scattering about a penny-shaped crack lying on a bimaterial interface. Loeber, J.F. (Knolls Atomic Power Lab., Schenectady, NY); Sih, G.C. pp 513-528 of In Dynamic crack propagation. Sih, G.C. (ed.). Leiden; Noordhoff International Publishing (1973).

From International conference on dynamic crack propagation; Bethlehem, Pennsylvania, USA (9 Jul 1972).

See CONF-720709—.

In order to assess the effects upon fracture processes of dynamic loading conditions in dissimilar material systems, a problem involving torsional wave scattering about a penny-shaped crack lying on a bimaterial interface is studied. The resulting mixed boundary value problem is solved using Hankel transforms to reduce the problem to one involving the numerical solution of a pair of coupled integral equations. Graphical results isolate the dependence of dynamic stress intensity factor and crack opening displacement upon wave number and ratios of shear modulus and density of the two materials. Emphasis is placed on comparisons between (1) dynamic and static results and (2) bimaterial to unimaterial results. (auth)

5173 Effects of hydrogen and oxygen on the elastic moduli of vanadium, niobium, and tantalum single crystals. Fisher, E.S.; Westlake, D.G.; Ockers, S.T. (Argonna National Lab., IL). *Phys. Status Solidi (a)*; **28**: No. 2, 591-602(16 Apr 1975).

Measurements of the ultrasonic wave velocities at 30 to 50 MHz frequencies reveal very significant effects of dissolved hydrogen on the elastic shear moduli, $C' = (C_{11} - C_{12})/2$ and C_{44}, of the group V bcc transition metals. In all cases, C' decreases with increasing hydrogen solute, whereas C_{44} increases and the bulk modulus remains nearly constant. The $\Delta C'$ effect is interpreted as a Snoek relaxation that arises from a tetragonal elastic dipole produced by interstitial hydrogen in tetrahedral sites. The data indicate that the tetragonal distortion parameter, $\text{lambda}_1 - \text{lambda}_2$, is 0.11 for V, 0.051 for Nb, and 0.047 for Ta. The rate of increase in C_{44} is 0.5 percent per at. percent hydrogen for V, 1.8 percent for Nb, and 0.13 percent for Ta. This increase is reflected in a positive change in the isotropic Young's modulus for Nb, opposing the Snoek relaxation effect. The addition of oxygen to V and Nb produces no Snoek relaxation at these high frequencies, but the positive change in C_{44} is as pronounced as in the hydrogen addition. Present information is not sufficient to relate this ΔC_{44} effect strictly to the interstitial solute configuration. (auth)

5174 Occurrence of transgranular cleavage-like fracture in an Al—Zn—Mg alloy during tensile testing. Nelson, J.L.; Pugh, E.N. (Univ. of Illinois, Urbana). *Metall. Trans.*; **6A**: 1459-1460(Jul 1975).

Observations are presented that show that, in addition to ductile fracture in high-purity Al—5.5 Zn—2.5 Mg alloys, transgranular cleavage-like fracture can also occur; this form of failure requires the presence of water and is dependent on strain rate and yield strength. (DLC)

5175 Second-, third-, and fourth-order elastic constants of β-brass. Swartz, K.D. (Baldwin Wallace Coll., Berea, OH); Bensch,

W.; Granato, A.V. *Phys. Rev., B;* 12: No. 6, 2125-2131(15 Sep 1975).

Complete sets of elastic constants of β-brass of two compositions are given. The fourth-order elastic constants are deduced from the temperature dependence of the second-order elastic constants. The elastic constants are explainable in terms of a Born-Mayer-type core exchange interaction between nearest and next-nearest neighbors. The next-nearest-neighbor contributions are greater than the nearest-neighbor contributions for C_{111} and C_{1111}, and provide stability for the small shear constant $C' = (C_{11} - C_{12})/2$. (auth)

PHYSICAL PROPERTIES

5176 (ANL—75-55) **Thermophysical properties of stainless steels.** Kim, C.S. (Argonne National Lab., Ill. (USA)). Sep 1975. Contract W-31-109-Eng-38. 28p. Dep. NTIS $4.00.

Recommended values of the thermodynamic and transport properties of stainless steels Type 304L and Type 316L are given for temperatures from 300 to 3000°K. The properties in the solid region were obtained by extrapolating available experimental data to the melting range, while appropriate correlations were used to estimate the properties in the liquid region. The properties evaluated include the enthalpy, entropy, specific heat, vapor pressure, density, thermal expansion coefficient, thermal conductivity, thermal diffusivity, and viscosity. (9 fig, 11 tables) (auth)

5177 (CEA-R—4698) **Intrinsic thermal expansion of point defects in aluminum.** Asty, M. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Etudes des Combustibles a Base de Plutonium). Nov 1975. 93p. (In French). Dep. NTIS (US Sales Only) $6.00.

Thesis. Submitted to Poitiers Univ., France.

The differential length measurement between two specimens, one pure and the other containing point defects, leads to the intrinsic thermal coefficient of expansion β/sub d/ of the defect, according to the relation: β/sub d/ = 1/ΔV/sub d/ (delta ΔV/sub d//delta T)/sub p/, ΔV/sub d/ being the formation volume of the defect. A description is given of a differential dilatometer using laser interferometry operating between 77 and 300°K, with a sensitivity of about 100 A on and the length difference between an alloy sample and a pure dummy. Concerning substitutional impurities in aluminium between -190 and -90°C, the β/sub d/ is shown to have an absolute value much larger than the thermal expansion coefficient β/sub o/ of the aluminium matrix: β/sub d//β/sub o/ approximately equal to +3 to +6 for the magnesium impurity, β/sub d//β/sub o/ approximately equal to -3 to -4 for the calcium impurity, and to be independent of the temperature. Existing theoretical models give evaluations far away from the experimental results. By quenching of a pure aluminium specimen from high temperature, results show that vacancies and divacancies, before collapsing in dislocation loops, form multivacancy clusters with large formation volumes; such a property makes these clusters comparable to cavities where the formation volume per vacancy is equal to the atomic volume of the matrix. 18 figs. (auth)

5178 (CONF-751209—7) **Bulk properties of UIr_2 and UIr_3.** Brodsky, M.B.; Trainor, R.J.; Arko, A.J.; Culbert, H.V. (Argonne National Lab., Ill. (USA)). Dec 1975. Contract W-31-109-Eng-38. 7p. Dep. NTIS $4.50.

From 21. annual conference on magnetism and magnetic materials; Philadelphia, Pennsylvania, USA (9 Dec 1975).

The electrical resistivity and magnetic susceptibility of the cubic intermetallic compounds UIr_2 ($MgCu_2$-type) and UIr_3 (ordered, $AuCu_3$-type) were measured between 2-300°K. The susceptibility of UIr_2 is temperature independent and substantially lower than that of isoelectronic URh_2, being 0.57 vs 0.97 x 10^{-3} emu/mole at room temperature. The susceptibility of UIr_2 is very weakly temperature dependent above 100°K and has a value of 1.18 x 10^{-3} emu/mole at room temperature. The electrical resistivities of both compounds follow power law dependences at low temperatures, of the form rho-rho$_o$ = AT/sup n/, with n = 1.9 for UIr_2 and n = 3.7 for UIr_3. These results indicate that UIr_2 may be a spin fluctuation compound, while UIr_3 behaves as a simple transition metal compound, with even less d-f character than URh_3 (n = 3.0). The specific heat of UIr_3 was measured between 1-4K and may be fit to $C = \gamma T + \beta T^3$, with a large value of γ, 62.5 mJ/(mole-K^2), which is consistent with a narrow 5f band at the Fermi level. The lack of any magnetic phenomena in UIr_3 is explained by the hybridization of the 5f electrons into f-d bands, which mostly lie below the Fermi level. (auth)

5179 (IS-T—697) **Electroreflectance of single crystal metals.** Furtak, T.E. (Ames Lab., Iowa (USA)). Dec 1975. Contract W-7405-eng-82. 162p. Dep. NTIS $7.75.

Measurements of the normal incidence, polarized light electroreflectance of clean, strain free (110) and (100) Ag, from 3 eV to 4.2 eV, and (110) Au, from 1.6 eV to 4.0 eV, were performed using the electrolyte technique in a novel drop configuration. At 3.9 eV in Ag a dramatic reproducible anisotropy in the negative peak in R^{-1} $\Delta R/\Delta PHI$, that was unquestionably correlated with the orientation of the crystal, was observed only on the (110) face. No anisotropy was detected in the electroreflectance of Au. A detailed study of the anisotropic spectrum was conducted as a function of surface preparation, solution composition, sample bias potential, and modulation amplitude. The results of this research have demonstrated beyond doubt that the electroreflectance on the (110) surface of Ag involves a modulation of electron states that possess the crystal surface symmetry. The most plausible interpretation, excluding such exotic mechanisms as intrinsic surface states or an anisotropic electron gas, involves a combined effect of a McIntyre-Aspnes-like charge modulation, which is responsible for the gross details, and field assisted indirect interband transitions which add an anisotropic contribution. (25 figures, 100 references) (auth)

5180 (LBL—4056) **Applications of time-differential perturbed angular correlations to the study of solids.** Schwartz, G.P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1975. Contract W-7405-Eng-48. 120p. Dep. NTIS $6.50.

Thesis.

Time-differential perturbed angular correlation techniques were applied to a systematic study of insulating antiferromagnets and rare-earth intermetallic alloys doped with either /sup 111m/Cd or ^{111}In. The internal magnetic fields and electric field gradients at the radioactive nucleus are deduced from the experimentally measured perturbation factors. The analysis of fluoride, chloride, oxide, and sulfide data shows the systematic variation of the observed supertransferred hyperfine fields with the intervening anion covalency and allows extraction of covalency parameters after the adoption of a simple model. A comparison of the transferred hyperfine field data between fluoride perovskites and the corresponding quadratic layer compounds produces a value for the zero-point spin deviation in magnetically two-dimensional antiferromagnets which is in qualitative agreement with existing theoretical estimates. Paramagnetic shifts due to transferred hyperfine field and field-induced spin-flopping have also been observed. By careful temperature regulation the temperature dependence of the sublattice magnetization can be plotted next to a diamagnetic impurity in $RbMnF_3$ and MnF_2. A shift in the transferred hyperfine field at Cd doped into MnS has been measured under the application of moderate pressures up to 22 kbar. Analysis of the electric field gradients at the In and Sn sites in the rare-earth series RIn_3 and RSn_3 as functions of temperature and pressure is the basis of a check for valence fluctuations in certain of these alloys. (auth)

5181 (UCRL—77290) **Helium release from type 304 stainless steel.** Cost, J.R.; Hickman, R.G.; Holt, J.B.; Borg, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Sep 1975. Contract W-7405-Eng-48. 23p. (CONF-751026—13). Dep. NTIS $4.25.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

Helium in very low concentration (less than 1 atomic ppB) has been introduced into type 304 stainless steel by radioactive decay of dissolved tritium. Release of this helium during subsequent annealing was monitored with a high sensitivity mass spectrometric gas analyzer. With isochronal annealing, helium is released in two temperature ranges, one near 300°C and the other between 800°C and the melting point. The latter release is interpreted as attributable to helium gas bubbles. The release near 300°C was studied isothermally between 150 and 300°C and is analyzed in terms of two stages of exponential decay. The fast and slow release stages have relaxation times near 10^2 and 10^3 s, respectively, and the fast release accounts for roughly 85 percent of the total release at low temperature. From an analysis of the temperature dependence of the release rate, it is concluded that volume diffusion is the controlling mechanism for the outgassing. (auth)

5182 **Inelastic magnetic scattering from amorphous $TbFe_2$.** Rhyne, J.J. (Naval Ordnance Lab., White Oak, MD); Price, D.L.; Mook, H.A. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 121-122(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Inelastic neutron scattering measurements were made on sputter-deposited amorphous Tb/sub Q33/Fe/sub Q67/ using time-of-flight spectrometers. At 433°K (above T/sub c/), the magnetic scattering function $S(Q,\omega)$ exhibited an approximate Gaussian dependence on energy transfer characteristic of a paramagnet. Below T/sub c/, at 299°K, a broad distribution of magnetic inelastic scat-

tering is present centered approximately at $\Delta E = 11$ MeV. As expected this distribution was significantly broadened and was shifted to a lower energy than the equivalent polycrystalline compound $TbFe_2$ which showed a single inelastic peak near 18 MeV. Polarized beam time-of-flight data showed evidence for discrete spin wave excitations for Q less than or equal to 1.0 A^{-1} in the amorphous sample. (auth)

5183 Multiplet splitting of x-ray photoemission spectra core levels in magnetic metals. Kowalczyk, S.P.; McFeely, F.R.; Ley, L.; Shirley, D.A. (Univ. of California, Berkeley). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 207-208(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Results of high-resolution x-ray photoemission studies of the multiplet splitting of the 3s core levels in the 3d transition metals and the 4s, 5s, and 4d core levels in the lanthanide metals are reported. (auth)

5184 Temperature independent ^{55}Mn magnetic hyperfine fields in $ErMn_2$ and $TmMn_2$. Barnes, R.G.; Lunde, B.K. (Ames Lab., IA). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 217-218(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Analysis of the complex NMR spectra of ^{55}Mn in the hexagonal Laves phase compounds $ErMn_2$ and $TmMn_2$ reveals only a very slight temperature dependence of the ^{55}Mn Knight shift K at either of the two inequivalent lattice sites, in contrast to the Curie—Weiss behavior of the susceptibility of these compounds and their known ferromagnetic ordering properties. In addition, K differs negligibly from that in isostructural $ScMn_2$ which does not order magnetically. Both neutron diffraction and NMR data indicate that Mn carries no local moment, and the Knight shift measurements suggest that K results essentially entirely from the orbital contribution, K/sub orb/. Unlike the case of the $LnAl_2$ cubic Laves phase compounds, for example, the net contribution to K resulting from indirect interaction between ^{55}Mn and the rare-earth moments is relatively small. (auth)

5185 Calorimetric evidence for spin fluctuations in UAl_2. Trainor, R.J. (Argonne National Lab., IL); Brodsky, M.B.; Isaacs, L.L. *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 220-222(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Results are presented of heat capacity measurements on UAl_2 between 1.8 and 400°K. The data are compared with recent resistivity and susceptibility measurements which indicate the existence of localized spin fluctuations in a narrow 5f band. Below about 50°K, the electronic contribution to the heat capacity becomes large, equivalent to γ approximately 70 mJ/mole-K^2. Below 6K, there is an upturn in C/T which is proportional to T^2 log (T/T/sub SF/), where T/sub SF/ = 10.6°K is identified as the spin fluctuation temperature. Extrapolation of this term to zero temperature yields m*/m approximately 2 for the spin-fluctuation mass enhancement. At 300°K, UAl_2 exhibits more typical metallic behavior, with γ approximately 15 mJ/mole-K^2. Data are also presented for nonmagnetic URh_3; at low temperatures $C = \gamma T + \beta T^3$, with $\gamma = 14.5$ mJ/mole-K^2 and β corresponding to theta/sub D/ = 336°K. (auth)

5186 Role of itinerant 5f states on the Fermi surface of Th and possible impurity local moment formation. Koelling, D.D. (Argonne National Lab., IL); Freeman, A.J. *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 223-224(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The nature (itinerant vs. localized) of the 5f electrons in the actinides determines their magnetic properties. Extensive optical and de Haas—van Alphen data which exist only for Th, the simplest actinide with no occupied 5f states, allow detailed comparisons to be made between theory and experiment. The 5f bands were found, by means of ab initio RAPW energy band calculations, to lie above the Fermi energy, to be itinerant in character and to significantly affect the reflectivity measurements of Veal, et al. We find that the 5f bands when included in the RAPW calculations, give excellent agreement with the deHaas-van Alphen results of Boyle and Gold, for all sections of the Lungs, Dumbell and Superegg Fermi surfaces, in contrast with calculations based on artificially removing the 5f resonance. Simple overlap charge density impurity scattering potential model calculations are used to discuss the possible occurrence of impurity local moment formation in Th based alloys. (auth)

5187 Field-induced transitions in DySb. Brun, T.O.; Lander, G.H.; Korty, F.W.; Kouvel, J.S. (Argonne National Lab., IL). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 244-245(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The NaCl-structured compound DySb, which in zero field transforms abruptly at T/sub N/ approximately 9.5°K to a Type-II antiferromagnetic (A) state with a nearly tetragonal lattice distortion, was previously found to exhibit rapid field-induced changes in magnetization at 1.5°K. The field-induced transitions in a DySb crystal were studied by neutron diffraction and magnetization measurements in fields up to approximately 60 kOe applied parallel to each of the principal axes. In the [100] case, the transition from the A to an intermediate ferrimagnetic (Q) state is first-order at 4.2°K (critical field H/sub c/ approximately 21 kOe) but is continuous from approximately 6 K up to T/sub N/, as H/sub c/ yields 0. The Q-to-paramagnetic (P) transition is rapid but continuous at 4.2°K (H/sub c/ approximately 40 kOe) and becomes broad as T/sub N/ is approached. In the [110] case the A-to-Q transition remains essentially first-order from 4.2°K (H/sub c/ approximately 15 kOe) up to T/sub N/; above T/sub N/ rapid P-to-Q transitions occur at very high fields. The magnetic structure of the Q state is found to be that of HoP. (auth)

5188 Generalized susceptibility of Sc metal. Rath, J. (Northwestern Univ., Evanston, IL); Gupta, R.P.; Freeman, A.J. *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 327-328(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The generalized magnetic susceptibility chi(vector q) of Sc metal was determined from accurate Augmented Plane Wave (APW) method calculations of their energy band structure using a novel computational scheme developed as an extension of the work of Lehmann and Taut and Jepsen and Andersen on the density of states problem. The procedure yields simple analytic expressions for the chi(vector q) integral inside a tetrahedral microzone of the Brillouin zone which depends only on the volume of the tetrahedron and the differences of the energies only at its corners. Constant matrix element results were obtained for Sc which show very good agreement with the results of Liu, Gupta and Sinha and with a first maxima in chi(vector q) at $(0,0,0.31)2\pi/c$ vs $(0,0,0.35)2\pi/c$ obtained by Liu et al. which relates very well to dilute rare-earth alloy magnetic ordering data vector q/sub m/ = $(0,0,0.28)$ $2\pi/c$ and to kink in the LA phonon dispersion curve at $(0,0,0.27)$ $2\pi/c$. (auth)

5189 Magnetic properties of uranium and plutonium laves phases with 3d transition elements. Lam, D.J.; Aldred, A.T. (Argonne National Lab., IL). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 349-350(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Magnetization of UMn_2, UFe_2, UCo_2, UNi_2, $PuMn_2$, $PuFe_2$, $PuCo_2$, and $PuNi_2$ were measured from 4 to 300°K in fields up to 14 kOe. Susceptibility of UMn_2 shows a small maximum near 240°K (which may indicate an antiferromagnetic transition) in agreement withprevious results. The data for UFe_2, UCo_2, and UNi_2 are not in good agreement with earlier work; the ferromagnetic ordering temperature (158°K) of a single crystal sample of UFe_2 is lower than any reported value, UNi_2 orders ferromagnetically at 30°K, and UCo_2 may order below 5°K. In contrast, $PuMn_2$, $PuCo_2$, and $PuNi_2$ have small weakly-temperature-dependent susceptibilities. $PuFe_2$ is ferromagnetic at room temperature, in agreement with previousMoessbauer results, and has a saturation moment of approximately 2.6 μ/sub B/mole. (auth)

5190 High-field susceptibility in ferromagnetic $NpOs_2$. Dunlap, B.D.; Aldred, A.T.; Lam, D.J.; Davidson, G.R. (Argonne National Lab., IL). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 351-352(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

$NpOs_2$ is known to be a ferromagnet with a Curie temperature of 7.5°K. Previous bulk magnetization measurements indicated a field-induced magnetization even well below the transition temperature. This was extended by a measurement of the local high-field susceptibility, using the Moessbauer effect in ^{237}Np. At 1.6°K, a susceptibility of $(1.2 \pm 0.2) \times 10^{-3}$ emu/mole is obtained, in general agreement with the bulk measurement. Such a large susceptibility is best understood by a model of itinerant magnetism, although other properties of the material indicate localized behavior. (auth)

5191 Magnetic susceptibility measurements on actinide—Be_{13} intermetallic compounds. Brodsky, M.B.; Friddle, R.J. (Argonne National Lab., IL). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 353-354(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Magnetic susceptibilities were measured between 2 and 300°K for the compounds $AnBe_{13}$ (An = Th, U, Np, Pu), all of which form the $NaZn_{13}$ structure. The susceptibility of $ThBe_{13}$ is temperature-independent. The data for UBe_{13} and $NpBe_{13}$ may follow two Curie—Weiss regions with the breaks occurring at 200 and 70°K respectively. The Curie—Weiss parameters are not substantially different for the two regimes, p/sub eff/ = 3.16 and 2.99 μ/sub B/ for UBe_{13}, and p/sub eff/ = 2.35 and 2.76 μ/sub B/ for $NpBe_{13}$. For $PuBe_{13}$, the Curie—Weiss fit requires a temperature independent term and yields $chi_o = 1.20 \times 10^{-3}$ emu/g, P/sub eff/ = 0.74 μ/sub B//Pu, and theta = +11°K. The intermediate coupling scheme yields $5f^2$, $5f^1$, $5f^0$ configurations for the U, Np, and Pu compounds, respectively. Thus, each actinide ion is trivalent if the f-electrons are considered to be localized. Of these compounds, only $PuBe_{13}$ gives evidence for long-range magnetic order, becoming antiferromagnetic at T/sub N/ = 11.5°K. (auth)

5192 Magnetic entropy and magnetization of $ZrZn_2$. Viswanathan, R.; Clinton, J.R. (Univ. of California, La Jolla, San Diego). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 416-417(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The previously published low temperature heat capacity data of four $ZrZn_2$ samples were analyzed to extract the magnetic entropy, S/sub m/(T). The well-ordered vapor deposited $ZrZn_2$ with T/sub c/ approximately 22°K showed a finite but small S/sub m/(T) of 110 mJ/gm mole°K, indicating that it is very much an itinerant electron ferromagnet. However the dramatic increase of S/sub m/(T) with the increase of Curie temperature suggests that better the samples more the deviation from the Stoner—Wohlfarth band theory. The magnetic measurements carried out on the same samples confirm the general applicability of the band theory and the sensitivity of the samples to the details of preparation and heat treatment. (auth)

5193 Fermi surface "nesting" in Tb alloys. Burgardt, P.; Legvold, S. (Ames Lab., IA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 418-419(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Magnetization and electrical resistivity measurements from 4.2 to 300°K were made on alloys of Tb with Th, Mg, and Yb in order to test valency effects on magnetic ordering in Tb. Tetravalent Th raises E/sub F/ and promotes ferromagnetism by reducing the "nesting" feature in the Tb Fermi surface. Divalent Mg and Yb lower E/sub F/ to enhance the "nesting" feature and promote the helical structure. Results are understood in terms of valency effects on the Fermi surface and impurity size effects. (auth)

5194 Neutron scattering and magnetization measurements on the Kondo compound $CeAl_3$. Edelstein, A.S. (Univ. of Illinois, Chicago); Brun, T.O.; Lander, G.H.; McMasters, O.D.; Gschneidner, K.A. Jr. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 428-429(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Previous measurements on the Kondo compound, $CeAl_3$ (hexagonal DO_{19}), indicate that with decreasing temperature it transforms gradually into a singlet state and does not magnetically order above 0.6°K. To determine the spatial extent of the magnetic moment, the spin-dependent cross section of neutrons diffracted from the (201) planes of a polycrystalline sample in 50 kOe was measured at 5, 19, and 81°K. At 50 kOe and these temperatures, the total moment from magnetization measurements on the same sample is only 5-15 percent lower than the moment determined by the neutrons if one assumes a 4f form factor. This approximate agreement supports the hypothesis that the moment decreases without changing its spatial distribution. A similar spatially uniform reduction of the moment occurs also in dilute Kondo systems. From the field dependence of the magnetization M, the characteristic or Kondo temperature is estimated to be 5.1°K. (auth)

5195 Magnetic and lattice properties of CeBi. Lander, G.H. (Argonne National Lab., IL); Mueller, M.H.; Vogt, O. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 430-431(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The magnetic structures of CeBi were examined as a function of field with neutron diffraction. At low fields, unusual domain reorientation effects are observed. For H greater than 18 kOe, a 3+, 1- spin configuration is found. A first-order transition to induced ferromagnetic behavior occurs at 47.5 kOe. X-ray experiments at low temperature show that no lattice distortion occurs at either T/sub N/ = 25°K or the I—IA transition at 12.5° A volume discontinuity is observed at the low temperature transition. (auth)

5196 Calculation of induced magnetic form factor of chromium. Oh, K.H. Ames, IA; Iowa State Univ. (1975). 70p. University Microfilms Order No. 75-17,407.

Thesis (Ph. D.).

Expressions for the induced magnetic form factor, which is the Fourier transform of the magnetization density, were formulated from first principles by using linear response theory. This shows that the form factor consists of spin and orbital contributions. The orbital form factor has been studied in detail, and it is shown to consist of the Landau-Peierls like diamagnetic terms, the Van Vleck like terms, and the core type diamagnetic terms. The required energy bands and Bloch wavefunctions were obtained from the augmented plane wave method on a π/6a mesh. The Pauli type spin form factor was found to be more contracted than the free ion 3d spin form factor, and the bulk susceptibility was less than the experimental value. It is concluded that (1) there should be an exchange enhancement for the spin form factor, and (2) the diamagnetic contributions from the Landau-Peierls terms and the core terms should be included in the orbital form factor in order to compare calculated values with the neutron diffraction results of Stassis et al. [Phys. Rev. Lett., 31: 1443(1973)] This gives the bulk spin susceptibility of 62×10^{-6} emu/mole and the orbital susceptibility of 101×10^{-6} emu/mole, which yields a gyromagnetic ratio of 1.23. This value is in good agreement with the direct measurement of 1.21 +- 0.07 by the Einstein-de Haas method. The adjusted induced magnetic form factor of Cr is in good agreement with the neutron diffraction results. (Diss. Abstr. Int., B)

5197 Radio-frequency size effect and the fermi surface of aluminum. Hartman, J.S. Ames, IA; Iowa State Univ. (1975). 188p. University Microfilms Order No. 75-17,394.

Thesis (Ph. D.).

The radio-frequency size effect (RFSE) was used to determine Fermi surface calipers in the (100), (110), and (111) planes for aluminium. The data were recorded using frequency modulation detection and phase sensitive techniques. The measurements were taken on flat, thin (100 to 180 microns) samples prepared from a large single crystal with a residual resistance ratio (RRR) of 13,000. Experimental angular data for each plane were compared with calipers taken from a computer calculation based on the nearly free electron (NFE) model of the second-zone hole surface for aluminum. The calculation yielded relative signal intensities expected for the second-zone signals from purely geometric considerations. These intensities were compared with the experimental results. Comparisons were also made with an adjusted NFE second-zone model which included estimates of edge rounding based on previous studies of aluminum. The effects of non-uniform sample thickness on the frequency study technique for finding the appropriate RFSE magnetic field value were examined. Results of theoretical calculations were compared with data recorded in this investigation. Special consideration was given to the method proposed by Cleveland for determining the frequency dependence of the RFSE line width and the resonant field value. It was found that the Cleveland method gave accurate results only for perfectly flat samples. For samples with non-uniform thickness, the resulting resonant field values were found to be lower than the appropriate value. This reduction was examined as a function of the thickness non-uniformity relative to the skin depth of the material. (Diss. Abstr. Int., B)

5198 Far-infrared spin and combination resonances of the holes in bismuth. Smith, B.T.; Chin, A.K.; Sievers, A.J. (Cornell Univ., Ithaca, NY). *Solid State Commun.;* **16**: 1051-1054(1975).

With the aid of far infrared transmission measurements on thick samples of bismuth in the Faraday geometry, both the spin and combination resonance of the holes were identified. (auth)

5199 Single crystalline elastic constants of Al_4Cu and Zr_3Ni. Eshelman, F.R. Ames, IA; Iowa State Univ. (1975). 55p. University Microfilms Order No.75-17,388.

Thesis (Ph. D.).

A pulse-echo-overlap system was used to measure the single crystalline elastic constants of the tetragonal Zr_3Ni and Al_4Cu phases in the temperature range 4.2 to 300°K. Mathematical relationships needed to calculate these elastic constants have been

determined. The longitudinal elastic constants of Zr_2Ni, C_{11} and C_{33}, both exhibit a monotonic decrease with increasing temperature. The C_{66} shear constant of Zr_2Ni has a 72 percent monotonic increase with increasing temperature in the 4.2 to 300°K range and the other shear constants, C_{44} and 1/2 (C_{11}-C_{12}), are essentially temperature independent. The shear constants are noticeably smaller than the longitudinal constants, with C_{66} only 3.5 percent of C_{11} at 4.2°K. All the elastic constants of Al_2Cu exhibit a monotonic decrease with increasing temperature. The C_{44} volues of Al_2Cu show a 2 percent variation with direction that has been attributed to the presence of occluded particles of a second phase whose long dimension is oriented normal to the [001] direction. There is evidence that Al_2Cu forms peritectically which gives rise to the second phase particles. Arguments are given to show that the maximum error from the occluded second phase particles is about 2 percent. Zr_2Ni and Al_2Cu both have low longitudinal elastic anisotropy ratios and at least one high shear anisotropy ratio. In addition, one shear anisotropy ratio changes by 50 percent or more in the 4.2 to 300°K temperature range. The polycrystalline moduli for Zr_2Ni and Al_2Cu from Voigt—Reuss—Hill averaging are given. The low shear modulus for Zr_2Ni is in keeping with the low values of the shear elastic constants of single crystals of this phase. The Debye temperatures for these phases are given. (Diss. Abstr. Int., B)

5200 Ceramic models for study of piezoelectricity in solids. Williams, W.S.; Breger, L.; Johnson, M. (Univ. of Illinois, Urbana). *J. Am. Ceram. Soc.;* **58**: No. 9-10, 415-417(1975).

From 75. annual meeting of the American Ceramic Society; Cincinnati, OH, USA (1 May 1973).

The piezoelectric behavior of certain biological materials (bone and tendon) was studied by comparing them with well-understood piezoelectric ceramics (quartz and tourmaline). The results show that, whereas the ceramic model materials conform to the standard theory of piezoelectricity in both compression and bending, the organic materials deviate quantitatively and qualitatively in bending. An extension of the formal theory is developed to include a polarization proportional to the gradient of the stress and yields predictions in accord with the experimental findings for bone and tendon. Implications for transducers competing with electrical ceramics are noted. (auth)

5201 Electron correlation in the narrow-band model for disordered ferromagnetic alloys. Abito, G.F. (Univ. of Iowa, Iowa City), Schweitzer, J.W. *Phys. Rev., B;* **11**: No. 1, 37-47(1 Jan 1975).

The ferromagnetism of a random disordered substitutional binary alloy described by the narrow-energy-band model of Hubbard is discussed within the framework of the coherent-potential approximation with strong correlation effects included. The treatment of Coulomb correlations used is an improved version of the first Hubbard approximation which seems to adequately describe those correlation effects that have a major influence on the stability of the ferromagnetic phase for large intra-atomic Coulomb repulsion. Disorder is considered in the site-diagonal terms of the Hubbard model. Numerical illustrations are presented that describe the ferromagnetic solutions in terms of the component magnetizations and component densities of states as functions of electron concentration in the band for several cases of disorder and alloy compositions. In these examples the intra-atomic Coulomb repulsion is assumed to be infinite. Comparisons are made with results obtained using a Coulomb repulsion of the order of the bandwidth treated by the Hartree-Fock approximation. The results are qualitatively similar for small electron concentrations and the examples show the differences at larger concentrations. A brief discussion with respect to experiment is made. (auth)

5202 Determination of the hole band gap in bismuth by far-infrared magnet-transmission. Smith, B.T.; Sievers, A.J. (Cornell Univ., Ithaca, NY). *Phys. Lett.;* **51A**: No. 5, 273-274(24 Mar 1975).

In the context of a two-band model, the hole gap-energy is determined to be 720 +- 160 MeV. (auth)

5203 Temperature dependence of the magnetization of nickel. Aldred, A.T. (Argonne National Lab., IL). *Phys. Rev., B;* **11**: No. 7, 2597-2601(1 Apr 1975).

The magnetization of a single-crystal nickel sample has been measured between 4 and 300°K in applied fields up to 13.5 kOe. The results are shown to fit spin-wave theory, but the numerical values of the spin-wave stiffness constants obtained are not in agreement with neutron-determined values. The discrepancy appears to be associated with a contribution to the temperature dependence of the magnetization from Stoner single-particle excitations; this contribution is found to be as large as the spin-wave term. (auth)

5204 Auger cascades in aluminum. McGuire, E.J. (Sandia Labs., Albuquerque, NM). *Phys. Rev., A;* **11**: No. 6, 1889-1898(Jun 1975).

Transition-rate expressions are developed to analyze the Auger cascade leading to multiply charged ions following inner-shell vacancy production. In general, the aim is to predict the intensity and spectral distribution of the soft x-ray emission occurring at the termination of the Auger cascade, to determine when and if there can be an inner-shell population inversion, and what pumping level must be achieved to obtain amplified spontaneous emission. Aluminum is examined in detail starting with an initial K-shell vacancy. It is found that there can be significant amplified spontaneous emission in the 160 to 170-A region providing that there is a hard x-ray flux of about 10^{11} W/cm^2 at energies greater than the Al K-shell binding energy. It is hypothesized that the recent observations of Jaegle et al., [Phys. Lett. 36A: 167(1971)] indicating gain at 117.4 A in a two-plasma experiment, can be accounted for via x-ray coupling between the plasmas. An experiment to check the hypothesis is advanced. (auth)

5205 Measurement of liquid metal diffusion coefficients from steady-state solidification experiments. Verhoeven, J.D.; Gibson, E.D.; Griffith, R.I. (Ames Lab., IA). *Metall. Trans.;* **6B**: 475-480(Sep 1975).

Steady state solidification experiments were carried out on Sn—Bi alloys of compositions from zero to 3.5 at. percent Bi with tube diameters from 1.9 to 5 mm. Solute profiles were determined utilizing a radioisotope, ^{207}Bi, and a microtome slicing technique. Results indicate the technique offers a relatively precise method for determining liquid metal diffusion coefficients at the solidus temperature. Convection does not appear to be a problem for tube diameters under 3 mm. It is shown that neglect of thermal transport may give errors in the measured diffusion coefficients as high as 10 to 30 percent. (auth)

5206 p-polarized optical properties of a metal with a diffusely scattering surface. Keller, J.M.; Fuchs, R.; Kliewer, K.L. (Ames Lab., IA). *Phys. Rev., B;* **12**: No. 6, 2012-2029(15 Sep 1975).

A theory is developed for the p-polarized optical properties of a semi-infinite electron gas with a surface that scatters the electrons diffusely. The electron gas response is described by the Boltzmann equation. An important ingredient of the theory is the use of a legitimate distribution function for electrons leaving the surface, one which permits the normal component of the current density to vanish at the surface. It is found that the optical absorptance below the plasma frequency is an order of magnitude too large if this boundary condition on the normal component of the current is ignored by simply using the unperturbed distribution function for electrons leaving the surface. The calculated absorptance is compared for diffusely and specularly scattering surfaces. Below the plasma frequency the absorptance is higher for diffuse scattering, as is also true for s polarization, while above the plasma frequency the absorptance is essentially the same for diffuse and specular scattering. Interesting structure occurs in the vicinity of the plasma frequency. (auth)

5207 Anderson—McMillan prescription for the density of states of liquid iron. Olson, J.J. (Univ. of California, San Diego, La Jolla). *Phys. Rev., B;* **12**: No. 8, 2908-2916(15 Oct 1975).

An intensive numerical investigation reveals a gross error in the density of states reported in 1967 by Anderson and McMillan. Whereas they obtained a broad double-peaked resonance that appeared sufficiently reasonable to justify their prescription, correct evaluation of their formula yields a single structureless resonance far too narrow to be representative of a transition-metal d band. This conclusion is verified by algebraically reducing their expression for the density of states to a form that is easily evaluated by hand. Anderson and McMillan also err in claiming that their dispersion relation leads to a vanishing wave number at resonance. The zero wave number is on an extraneous branch and would have led to a nonintegrable singularity in their density of states. Evidently the Anderson—McMillan prescription is inadequate as a description of the effects of s-d hybridization on the density of states of transition metals. (auth)

5208 Band structure of face-centered and body-centered-cubic 3d transition metals. McAlister, A.J. (National Bureau of Standards, Gaithersburg, MD); Cuthill, J.R.; Dobbyn, R.C.; Williams, M.L.; Watson, R.E. *Phys. Rev., B;* **12**: No. 8, 2973-2983(15 Oct 1975).

Measurements of the soft-x-ray $M_{2,3}$ emission spectra of face-centered Fe and Co, and body-centered Fe, Cr, and V are reported and M_5 single-hole excitation profiles are estimated. 3d bandwidths inferred from these results and earlier data on Cu and Ni are compared with band-theory predictions. As has been seen previously with x-ray and ultraviolet photoemission, the experimental Ni bandwidth is markedly narrower than theory predicts; there

is a suggestion that the bandwidth of Cu is somewhat broader; theory and the present results are in fair agreement for the other metals. Fine structure is seen in the spectra; correlations are noted in the weak structure of metals of common crystal structure; and structural correlations with x-ray and ultraviolet photoemission data are seen as well. (auth)

CORROSION AND EROSION

5209 (GEAP—14029-3) **Steam generator materials engineering. Third quarterly report, January—March 1975.** (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Apr 1975. Contract AT(04-3)-893. 22p. AT.

5210 (GEAP—14029-4) **Steam generator materials engineering. Progress report, April—June 1975.** (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jul 1975. Contract AT(04-3)-893. 33p. AT.

The primary objective of the work reported is to characterize materials, mainly $2^1/_4$Cr—1Mo and stainless steels, to assure that satisfactory materials compatibility is achieved with expected LMFBR steam generator environments. Major accomplishments for this quarter were as follows: Decarburization exposure in sodium achieved 10,000 hours; anodic polarization curves were completed on $2^1/_4$Cr—1Mo and Incoloy 800; creep-fatigue tests of Type-316 stainless steel in high carbon sodium are in progress (initial creep data were obtained); and the Intermediate System Mockup Loop was completed and sodium was pumped through the loop for five hours. (DLC)

5211 (KAPL-P—4042) **Consequences of improper evaluation of corrosion related failures: case histories reviewed.** Suss, H. (Knolls Atomic Power Lab., Schenectady, N.Y. (USA)). 1975. 21p. (CONF-751123—1). Dep. NTIS $4.50.

From ASM-TMS;AIME materials science symposium; Cincinnati, Ohio, USA (13 Nov 1975).

Three case histories are reviewed in which the initial evaluation was wrong but was revised; the potential problems that could have developed had not the initial evaluation been modified are described. The case histories are: AISI 440C (R/sub c/ 50—55) for bearing application in which a "stress-corrosion" crack was found to be a mechanical one caused by overload; perforations in brass tubes of heat exchanger which were found to be caused by vibrations and not by attack by acid cleaning solution; and cracking of a type 304 stainless steel bellows which was eventually determined to be due to caustic stress corrosion and not to chloride stress corrosion. (DLC)

5212 (LBL—2730) **Periodic phenomena in the high current density anodic dissolution of copper.** Cooper, J.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1975. Contract W-7405-ENG-48. 238p. Dep. NTIS $15.00.

Thesis.

5213 (ORNL—5080) **Twin boundary cavitation in aged type 304 stainless steel.** Sikka, V.K.; Swindeman, R.W.; Brinkman, C.R. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 40p. Dep. NTIS $4.00.

A transition from grain to twin boundary cavitation was observed in aged-and-creep-tested type 304 stainless steel. Evidence of twin boundary cavitation has also been observed for unaged material under certain test conditions. This same behavior was also found in aged type 316 stainless steel. Several possible reasons have been suggested for the absence of frequently observed grain boundary cavitation. (auth)

5214 (UCRL-Trans—10911) **Cracking of steels in condensates containing hydrogen sulfide.** Zav'yalova, E.P.; Ioannidis, O.K.; Abdullin, R.A. Translated from *Korroz. Zashch. Neftegazov. Promsti.;* No. 3, 3-5(1972). 9p. Dep. NTIS $4.00.

Steel-D possesses a great tendency to crack in a hydrogen sulfide medium. The threshold load lies below 10 kgf/mm². Lowering the medium pH will decrease the time until destruction. The concentration of hydrogen sulfide has little influence on the time until sample destruction. The quantity of hydrogen does not unequivocally determine the time until destruction. (auth)

5215 (UCRL-Trans—10918) **Selection of steels for christmas trees working in H_2S-containing media.** Levitskii, N.Z.; Zav'yalova, E.P.; Plyushcheva, F.M.; Vasil'eva, G.N. Translated from *Korroz. Zashch. Neftegazov. Prom-sti.;* No. 7, 24-29(1973). 11p. Dep. NTIS $4.50.

"Christmas trees" are used in the gas industry to seal the heads of gas wells for regulating the gas production. Carbon steels, low-alloy steels, and high-alloys were tested as well as coating and welded-on steels for general corrosion and stress-corrosion sulfide cracking. Tensile properties and effects of pH were studied. Best results were obtained for the low-alloy steels and for 00Kh20N8M3D2 and 00Kh20N33Yu2TZ. (DLC)

5216 (UCRL-Trans—10934) **Stress corrosion of welded petrochemical equipment in the presence of hydrogen sulfide.** Nekanda-Trepka, L.; Kolakowski, B.; Sulkonski, S. Translated from *Przegl. Spawalnictwa;* 25: No. 3, 49-53(Mar 1973). 16p. Dep. NTIS $4.50.

5217 **Zirconium—oxygen photoflash reaction at oxygen pressures from 1 to 124 atmospheres.** Nelson, L.S. (Sandia Labs., Albuquerque, NM); Northrup, C.M.M. Jr.; Wemple, R.P.; Richardson, N.L.; Fastle, D.J.; Planner, H.N.; Keil, K. pp Paper No. 74-34 of In Combustion modeling: urban and wildland fires. Northridge, CA; Western States Section/The Combustion Inst. (1974).

From Meeting of the Western States Section;The Combustion Institute; Northridge, California, USA (21 Oct 1974).

See CONF-741049—.

The zirconium wool-oxygen photoflash reaction has been studied in oxygen at pressures from 1 to 125 atmospheres. The luminous emission was studied with photomultiplier and calibrated photographic spectroscopic techniques; also, the reactions were photographed with a high speed camera. The wool combustion is a highly chaotic process occurring as a summation at any given instant of individual droplets with varying diameters having reacted to different degrees. Vapor phase-related phenomena (explosions, halos, and smoke deposition) are suppressed or reduced at higher oxygen pressures, probably due to the increased hydrostatic forces. The light emitted increases in peak intensity (2-fold in the red to 4.5-fold in the blue), and decreases in pulse width and pulse asymmetry as the oxygen pressure is increased from 1 to 125 atmospheres. At the same time, the average peak radiance temperature increases from about 3600 K to 4400 K. The emission approximates a blackbody to within +-3 percent even at the highest pressures, but the temperature falls considerably below that expected from published vapor pressure/temperature relationships for the zirconium—oxygen system. (auth)

5218 **Correlation between explosion times and initial molar content for metal droplets burning in air.** Nelson, L.S. (Sandia Labs., Albuquerque, NM); Freese, J.M.; Richardson, N.L.; Planner, H.N.; Keil, K. pp Paper No. 74-35 of In Combustion modeling: urban and wildland fires. Northridge, CA; Western States Section/The Combustion Inst. (1974).

From Meeting of the Western States Section;The Combustion Institute; Northridge, California, USA (21 Oct 1974).

See CONF-741049—.

The free-fall combustion of submillimeter-diameter droplets of eleven transition and rare earth metals in dry air has been studied by a laser ignition technique. Each metal burned in a similar, coherent manner and exploded after a reproducible combustion time. For a given droplet diameter, a linear correlation between the time to explode and the number of moles of metal present in the droplet upon ignition was discovered. If the analogy may be drawn with earlier work on zirconium droplet combustion, the apparent oxygen transfer rate is constant from metal to metal. Since it is unlikely that all eleven metals have identical intrinsic oxygen uptake rates, the oxygen supply must be limited by diffusion through the boundary layer which surrounds the droplets for the combustion conditions studied here. These experiments place a lower limit on the intrinsic oxygen uptake rates of the eleven molten metals during high temperature oxidation. (auth)

5219 **Fractography of transgranular stress corrosion failures in a Mg—Al alloy.** Chakrapani, D.G.; Pugh, E.N. (Univ. of Illinois, Urbana). *Corrosion;* 31: No. 7, 247-252(Jul 1975).

A fractographic study was carried out on transgranular stress-corrosion cracks produced in both tensile and bend specimens of a Mg—7.5 Al alloy tested in an aqueous NaCl—K_2CrOCO solution. It is concluded that the complex fractography reported in earlier papers is fully consistent with the view that failure occurs basically by cleavage on [31 aeti 4 0] planes. Thus the course markings reported previously are shown to correspond to a stepped or pleated topography consisting of alternate faces produced by (31 anti 4 0) cleavage and ductile rupture parallel to (0001), the latter exhibiting flutings of the type observed in other hcp alloys. Reasons for the occurrence of the ductile component are discussed. (auth)

5220 **Solubility of RH/sub 2-x/ in Gd, Er, Tm, Lu, and Y from ambient to 850°C.** Beaudry, B.J.; Spedding, F.H. (Ames Lab., IA). *Metall. Trans., B;* 6B: 419-427(Sep 1975).

The solubility of hydrogen in Gd, Er, Tm, Lu, and Y was determined from 25 to 850°C when the metal was in equilibrium with RH/sub 2-x/ (x varies between 0.1 and 0.2 depending on the rare earth metal). The room temperature solubilities determined

by the lattice parametric method were found to be less than 0.1, 3.6, 7.7, 20.6, and 19.0 at. percent H in Gd, Er, Tm, Lu, and Y, respectively. The change in unit cell volume for each atomic percent hydrogen added was nearly the same for all metals. The solubility of hydrogen increases more rapidly with temperature in those metals with low solubility at room temperature. Thus the solubility of hydrogen at 850°C is nearly the same in all five of the metals studied, that is, 35.0, 36.2, 36.0, 36.0, and 37.3 at. percent H in Gd, Er, Tm, Lu, and Y, respectively. The equilibrium pressure of H_2 in these studies was the equilibrium pressure of hydrogen in contact with RH/sub 2-x/ at the temperature concerned. A change in slope was observed in the solubility curves of the Gd—, Er—, Tm—, and Lu—H systems. The log C (at. percent H in R) was plotted vs 1/T for each system. Straight lines were obtained at temperatures above and below the changes in slope of the solubility curves. A calculation of the approximate ΔH of solution of RH/sub 2-x/ in the metals from the slope of the lines gave 4.35, 1.88, 1.28, 0.61, and 0.55 kcal/mole for Gd, Er, Tm, Lu, and Y, respectively in the low temperature portion. The change in slope which occurs at some point between 350 and 650°C, depending on the metal, indicates a lower heat of solution of RH/sub 2-x/ in these metals at the higher temperatures. In Lu there appears to be yet another change in slope in the neighborhood of 250°C. (auth)

5221 Stress corrosion cracking of Ti—8Al—1Mo—1V in molten salts. Smyrl, W.H. (Sandia Labs., Albuquerque, NM); Blackburn, M.J. *Corrosion;* 31: No. 10, 370-375(Oct 1975).

From International conference on stress corrosion mechanisms in titanium alloys; Atlanta, GA, USA (Feb 1975).

The stress corrosion cracking (SCC) behavior of Ti—8Al—1Mo—1V has been studied in several molten salt environments. Extensive data are reported for the alloy in highly pure LiCl—KCl. The influence of the metallurgical heat treatment and texture, and the mechanical microstructure show similarities with aqueous solutions at lower temperature. The fracture path and cracking modes are also similar to that found in other environments. The influence of H_2O and H^- in molten LiCl—KCl led to the conclusion that hydrogen does not play a major role in crack extension in this environment. (auth)

5222 Composition of eta carbide phase in 2 1/4 Cr—1 Mo steel. Leitnaker, J.M.; Klueh, R.L.; Laing, W.R. (Oak Ridge National Lab., TN). *Metall. Trans., A;* 6A: No. 10, 1949-1955(Oct 1975).

The metal-to-carbon ratio in the eta phase in $2^1/_4$ Cr—1 Mo steel exposed to sodium at 566°C for 26,500 h, and probably under a variety of service conditions, approaches four, rather than six, a fact which may be influenced by the presence of Si, O, and perhaps Cr. Silicon is present in the eta phase, probably on a metal sublattice, while oxygen is probably present on the metalloid sublattice. The observation is supported by both structural and compositional data from the literature. (auth)

5223 ISS depth profile analysis of anodized niobium. Gray, K.E. (Solid State Science Division and Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Appl. Phys. Lett.;* 27: No. 8, 462-464(15 Oct 1975).

The first several hundred atomic layers of anodized niobium were studied using ion scattering spectrometer analysis alternated with ion milling. The results show excess oxygen at the surface followed by a layer of stoichiometric Nb_2O_5. Below this was an unexpected ~ 80-A layer of NbO and, finally, the bulk metal, with oxygen in solid solution. These results have important consequences for some ac superconducting applications since NbO is a normal metal above 1.38°K.

RADIATION EFFECTS

5224 (CONF-751006—12) Suppression of void formation in nickel by a dynamic trapping mechanism. Sorensen, S.M. Jr.; Chen, C.W. (Ames Lab., Iowa (USA)). 1975. 7p. Dep. NTIS $4.50.

From International conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

The effect of carbon on void formation in high purity nickel under neutron irradiation to four fluences ranging from 4×10^{19} to 2×10^{20} n/cm² (E greater than 0.1 MeV) at 500°C was investigated using transmission electron microscopy. In samples containing up to 84 wt ppM C, cubic voids were observed, and the void size tended to increase with increasing C content, while the void density decreased at much greater rates. Consequently, the associated swelling was seen to be steadily reduced. In samples containing 600 ppM C, void formation was completely suppressed, and an irradiation-induced dissolution of graphite precipitates occurred. The suppression of void formation in the irradiated Ni is attributed to an effective trapping mechanism associated with the interstitial C atoms in solution. Quantitative analyses on the size and density of voids reveal that the suppressing effect of C is mainly on void nucleation, not on growth. This trapping mechanism is considered to be dynamic in nature because the traps served by the C atoms can move through the lattice rapidly during irradiation until they are anchored in defect complexes. (auth)

5225 (CONF-751006—13) Ni ion damage in Cu and Nb. Roberto, J.B.; Narayan, J. (Oak Ridge National Lab., Tenn. (USA)). 1975. 8p. Dep. NTIS $4.50.

From International conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

Ni ion damage in Cu was studied using x-ray diffuse scattering and transmission electron microscopy, and in Nb using x-ray diffuse scattering. Single crystals of Cu and Nb were irradiated at room temperature to a fluence of 1.2×10^{15}/cm² at 60 MeV, and Cu was also irradiated to 5×10^{12}/cm² at 4 MeV. The x-ray diffuse scattering from loop-type defect clusters in the crystals was measured near several Bragg reflections in order to probe the depth distributions of the damage. In Cu, cluster size distributions derived from the x-ray measurements agreed well with TEM results. Comparison with fission reactor irradiations using the damage energy concept suggests similarities in retained damage between the neutron and Ni ion irradiations. (auth)

5226 (CONF-751006—14) Effect of Be doping on void swelling in nickel. Okamoto, P.R.; Taylor, A.; Wiedersich, H. (Argonne National Lab., Ill. (USA)). Oct 1975. Contract W-31-109-Eng-38. 9p. Dep. NTIS $4.50.

From International conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

Ni—Be alloys containing 0.1, 0.3, and 0.7 at. percent beryllium were irradiated with 3.2-MeV $^{58}Ni^+$ ions at 425, 525, and 625°C. Dose levels between 1 and 30 dpa were obtained at a calculated dose rate of approximately 3×10^{-3} dpa/s. Preliminary transmission-electron microscopy examinations of samples irradiated to approximately 17 dpa show that at 525 and 625°C the void volume fraction in the Ni—0.1 at. percent Be alloy is quite similar to that in pure Ni. However, between 0.1 and 0.7 at. percent Be, the void volume fraction decreases by a factor of approximately 40 at 525°C and approximately 3 at 625°C. (auth)

5227 (CONF-751006—16) Low temperature recovery of radiation damage in vanadium. Klabunde, C.E.; Coltman, R.R. Jr.; Williams, J.M. (Oak Ridge National Lab., Tenn. (USA)). 1975. 8p. Dep. NTIS $4.50.

From International conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

Some kind of order may emerge from the numerous anomalies in the low-temperature recovery of irradiated V if it is assumed that Stage I (first recovery by interstitial migration) occurs below 4°K. Present supporting evidence includes: from both thermal neutron and fission neutron damage studies (1) a continuous, nearly structureless recovery from 4 to 43°K independent of dose; (2) a nonlinear, decreasing damage rate at 4°K; and (3) from 6°K electron irradiations near threshold energy there is derived a Frenkel pair resistivity which is so small as to suggest significant loss of defects during irradiation. The assumption of a very low-lying Stage I also helps to explain several other unusual aspects of the data, especially those relating to the sharp recovery peak at 47°K. This is clearly a single first-order process (with a measured activation energy of 0.13 eV), but it has a strong positive dependence of population percentage upon dose, opposite to Stage II impurity detrapping peaks in several fcc metals. Also, the peak has a strong negative dependence upon irradiation temperature when equal doses put in at 4 and 31°K are compared. (auth)

5228 (CONF-751006—18) Replacement collision sequences in metals. Blewitt, T.H.; Kirk, M.A.; Scott, T.L. (Argonne National Lab., Ill. (USA)). Oct 1975. Contract W-31-109-Eng-38. 20p. Dep. NTIS $4.50.

From International conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

The concept of radiation-induced defects traveling large distances by focussed collision sequences (focusons) without thermal activation has important consequences in radiation effect studies. The focussed collision sequences are of two types: (1) "Silsbee focussing" or momentum focussing which can cause defect pairs to form large distances from the primary knock-on and (2) focussed replacement collisions also called "dynamic crowdions" where mass transport causes a large separation between the vacancy and its interstitial. Direct experimental evidence for focussed collision sequences is in short supply and conflicting. The sputtering patterns associated with close packed crystalline directions from the backscattering of charged particles seemed to substantiate long-range focussed collisions until it was pointed out that collision chains need not be long to yield such patterns. More recently, transmission sputtering has been used with conflicting results. Ecker et al. found no evidence for focusons greater than

17 atom distances whereas preliminary results of Siedman et al. suggest several hundred atom distances. Keil and co-workers found evidence for replacement collision sequences of 100 atom distances by stereo electron microscopy of interstitial agglomerates interjected by low energy heavy ion bombardment. Experiments by Kirk et al. and Becker and co-workers on ordered alloys, are only sensitive to dynamic crowdions. Kirk and co-workers result on the changes in magnetic properties of Ni_3Mn induced by thermal neutron bombardment strongly support long range focusons (greater than 30 atom distances) whereas Wollenberger found no evidence for focusons with 1 and 3 MeV electron irradiation. Theoretical treatments of Liebfried suggest a maximum length of 30 atom distances whereas Holmes' modified treatment suggests less than 10 atom distances. (10 fig, 23 references) (auth)

5229 (CONF-751026—6) **Production of point defects in 14.8 MeV neutron-irradiated MgO.** Chen, Y.; Abraham, M.M.; Robinson, M.T.; Mitchell, J.B.; Van Konynenburg, R.A. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. 9p. Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

High-purity MgO crystals grown at ORNL were irradiated in the LLL 14.8-MeV Rotating Target Neutron Source (RTNS) to doses varying from 1.8×10^{15} to 5.7×10^{17} n/cm². The optical absorption spectra of these crystals resembled those irradiated in fission reactors and exhibited bands principally at 4.95, 3.5, 2.2, and 1.3 eV. The band with the largest absorption coefficient, that at 4.95 eV, is due to anion vacancies. The bands at 3.5 and 1.3 eV, attended by zero-phonon lines at 3.430 and 1.187 eV respectively, are attributed to different optical transitions of anion divacancies. The investigations indicate that the net production rates of the point defects resulting from irradiations with 14.8-MeV neutrons are about twice those resulting from fission neutrons in the Oak Ridge Reactor (ORR). This ratio is in reasonable accord with theoretical estimates based on damage energy calculations. (auth)

5230 (CONF-751026—8) **15 MeV neutron damage in Cu and Nb.** Roberto, J.B.; Narayan, J.; Saltmarsh, M.J. (Oak Ridge National Lab., Tenn. (USA)). 1975. 17p. Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

An investigation was made of high-energy neutron damage in Cu and Nb irradiated with approximately 15 MeV neutrons at the Oak Ridge Isochronous Cyclotron. The neutrons were generated by bombarding a thick Be target with 40-MeV deuterons resulting in a high energy neutron spectrum broadly peaked at 15 MeV. Single crystals of Cu and Nb were irradiated at room temperature to fluences of approximately 2×10^{17} n/cm². The resulting loop-type defect clusters in the crystals were characterized using x-ray diffuse scattering and transmission electron microscopy. The cluster size distributions were found to be generally similar to those characteristic of fission neutron irradiations in these materials and no multiple clusters or sub-clusters were observed. Additional comparisons with fission reactor irradiations in Cu and Nb indicate that the retained displacement damage in these crystals is approximately 3 times greater for the high-energy neutrons than for an equivalent fluence of fission neutrons. This result is consistent with detailed damage energy calculations for the Be(d,n) neutron spectrum. (auth)

5231 (COO—3158-45) **Study of stages I to IV of irradiated or quenched tungsten and tungsten alloys by field-ion microscopy.** Seidman, D.N.; Wilson, K.L.; Nielsen, C.H. (Cornell Univ., Ithaca, N.Y. (USA)). Sep 1975. 25p. (CONF-751006—17). Dep. NTIS $4.50.

From International conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

Progress since 1972 in applying the quantitative field-ion microscope (FIM) technique to the study of point defects in irradiated tungsten and tungsten alloys or quenched tungsten is reviewed. Emphasis was on ascertaining recovery mechanisms for the major recovery stages which are consistent with both other FIM observations as well as observations employing more macroscopic techniques; hence point defect recovery models are presented for recovery Stages I to III. (49 references) (auth)

5232 (HEDL-SA—1036) **Irradiation creep in the absence of swelling.** Gilbert, E.R.; Bates, J.F. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1975. Contract E(45-1)-2170. 11p. (CONF-751051—1; CONF-751101—41). Dep. NTIS $4.50.

From US-German info exchange meeting; Washington, District of Columbia, USA (13 Oct 1975).

In-reactor creep of helium-pressurized 20 percent cold-worked Type 316 stain steel tubes was investigated at 375 to 575°C. The creep strain was found to be in excess of the thermal creep of unirradiated specimens and the strain rate increased both with temperature and neutron fluence. These results are not clearly predicted by contemporary theories of creep during neutron irradiation. (auth)

5233 (SAND—75-5386) **Enhanced diffusion of Zn in Al under Ne irradiation.** Myers, S.M. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 7p. (CONF-751006—10). Dep. NTIS $4.00.

From International conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

The diffusion rate of Zn in Al has been enhanced by factors approximately 10^2—10^4 under 80 keV Ne irradiation at 130°C. Diffusion couples were formed by ion implantation of Zn, and the concentration profiles were determined by ion backscattering. The data are analyzed by numerically solving the coupled diffusion equations for vacancies, interstitials and atoms, and by scaling the profiles of vacancy and interstitial production rates from the theoretical profile of Ne energy into atomic processes. The enhanced diffusion rate is linear in flux, indicating that the mobile point defects annihilate predominantly at fixed sinks. The average distance to annihilation is approximately 700 A, except for the first approximately 500 A of the solid where it is much less. Free vacancies and interstitials are found to be created by the Ne at a smaller rate than the atomic displacement rate, suggesting a high annihilation probability within the parent damage cascade. (auth)

5234 (SAND—75-5615) **Energy dependence of channeling analysis in implantation damaged Al.** Rimini, E.; Campisano, S.U.; Foti, G.; Baeri, P.; Picraux, S.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 8p. Dep. NTIS $4.50.

Ion channeling and backscattering measurements along the (110) axis of implantation disorder in Al single crystal are reported as a function of the He analyzing beam energy (0.5-2.0 MeV). For 100-keV N^+ implants (8×10^{16} ions/cm²), appreciable dechanneling is observed near the end of the projected ion range (2400 A) and the minimum yield increases with decreasing analyzing beam energy. A different behavior was observed for 150-keV Zn^+ implantation into Al with fluences of 6×10^{15} and 1.2×10^{16} ions/cm², respectively. The minimum yield in the Zn-implanted region (790 A) shows a $\sqrt{E}$ dependence on the energy E of the analysis beam. These channeling measurements show that the nature of the disorder for light and heavy mass implants in Al is different. The energy dependence of the minimum yield points out that the defects for the N implant are consistent with random scattering centers while for Zn implants extended defects with associated strains, like dislocations, are produced. The energy dependence of the critical angle can also be related to the defect structure. (auth)

5235 (SAND—75-5762) **Effects of ion implantation on amorphous Gd—Co.** Venturini, E.L.; Richards, P.M.; Borders, J.A.; EerNisse, E.P. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 8p. Dep. NTIS $4.50.

Studies of stress, composition, and magnetic properties were made on amorphous Gd—Co thin films implanted with nitrogen ions at fluences between 10^{15} and 10^{16} ions/cm². The lateral stress peaks at 2×10^{11} dynes/cm² for a fluence of 10^{14} ions/cm². Magnetic resonance reveals that the net anisotropy H/sub A/ - 4πM in the implanted layer decreases in the range of 10^{14} to 10^{15} ions/cm² and ultimately achieves a negative value considerably larger in magnitude than 4πM in the film prior to the implantation. This effect can be partly explained by a reduction of Gd content in the implanted layer. But there have to be structural changes as well which alter the microscopic parameters. (auth)

5236 (UCRL—77345) **Stage III dislocation pinning in silver resulting from gamma irradiation.** Van Konynenburg, R.A.; Guinan, M.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Sep 1975. 9p. (CONF-751006—8). Dep. NTIS $4.00.

From International conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

The objectives of this work were fourfold: (1) to test the validity of the vibrating string dislocation model in silver, (2) to determine in which annealing stage long-range migration first occurs, (3) to measure the migration energy and identify the defect responsible for observed annealing, and (4) to investigate the possibility of dislocation pipe diffusion. Apparatus is described which is capable of continuously measuring changes in the elastic modulus and internal friction during gamma irradiation over the temperature range from less than 4°K to well above room temperature. A novel hollow-cylinder sample geometry permits use of a source strength of only 1 Ci. Survey experiments over a wide temperature range and isothermal irradiations above room temperature are discussed. The results are explained in terms of the Koehler-

Granato-Lucke vibrating string dislocation model and the Thompson-BuckeHuntington-Barnes defect-dislocation interaction model. (auth)

5237 Deviation from Matthiessen's rule in electron-irradiated copper. Alldredge, O.R.; DeFord, J.W.; Sosin, A. (Univ. of Utah, Salt Lake City). *Phys. Rev., B;* **11**: No. 8, 2860-2870(15 Apr 1975).

Deviations from Matthiessen's rule (which states that the electrical-resistivity contributions of two different types of scatterers in a metal are additive) occur generally. The deviations arising from relatively simple scatterers: by point defects created by electron irradiation and by phonons are examined. Deviations from Mattiessen's rule in pure copper were studied over as wide a temperature range as possible. The deviations were studied as effected by recovery in the first three major defect annealing stages. When analyzing effects due to stage-I annealing, damage was produced by irradiation at 4°K; in stages II and III, damage was produced at 4 and at 80°K. In all cases, the electron energy was 1.5 MeV. The deviations were analyzed by considering two mechanisms: the two-band model and changes in the temperature-dependent part of the electrical resistivity. At low temperatures (below 35°K) the two-band form explains the data when separate temperature dependences for scattering of neck and belly electrons are taken into account. Contributions due to changes in the temperature-dependent part of the electrical resistivity appeared to play no substantial part. In the stage-II region the deviations arising from irradiation at 4°K and irradiation at 80°K were of a similar form, indicating that the nature of the irradiation-induced scatterers in both cases were essentially the same. In the stage-III region, contributions to the deviation from changes in the temperature-dependent part of the electrical resistivity were quite large. Similarities between the deviations here and those arising in the neutron-irradiated copper without stage-III annealing give support to the model that the mobile defect in stage III is the vacancy. (auth)

5238 Microyielding and effect of electron irradiation in high-purity iron single crystals. Sato, A.; Meshii, M. (Northwestern Univ., Evanston, IL). *Phys. Status Solidi (a);* **28**: No. 2, 561-569(16 Apr 1975).

The effect of electron irradiation on the microyield stress was investigated in ZrH_2 purified Battelle-AISI iron single crystals at 4.2, 30, and 60°K. The irradiation caused a hardening effect which increased with the electron dose. This hardening effect in the microyielding is opposite to the observed softening effect in the macroyielding. These observations can be satisfactorily explained by the interaction of the irradiation-induced interstitials with edge and screw dislocations, respectively. The present observation is also regarded as strong evidence supporting the theory of an intrinsic mechanism for the low temperature strength and the solid solution softening in iron. (auth)

5239 Report to the American Physical Society by the study group on physics problems relating to energy technologies: Radiation effects on materials. Vook, F.L.; Birnbaum, H.K.; Blewitt, T.H.; Brown, W.L.; Corbett, J.W.; Crawford, J.H. Jr.; Goland, A.N.; Kulcinski, G.L.; Robinson, M.T.; Seidman, D.N.; Young, F.W. Jr.; Bardeen, J.; Balluffi, R.W.; Koehler, J.S.; Vineyard, G.H. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Rev. Mod. Phys.;* **47**: S1-S44(2 Oct 1975).

An APS sponsored study reviewed the state of research and development in radiation effects on materials for the purpose of identifying basic scientific problems which limit progress in energy applications and which could be attacked by physicists, especially those in universities. The field of radiation effects on materials has particular application throughout fission and fusion reactor technology, and the technological problems associated with these reactors were reviewed. Important scientific problem areas discussed included mechanical properties, point defects, voids and dislocations, theory of damage production, charged particle simulation of neutron damage, hydrogen and helium in materials, interaction of surfaces and radiation, insulators, semiconductors, and superconductivity. In addition to many detailed suggestions, the study recommended increased effort on the following most important problem areas: A firm experimental and theoretical base for ion and electron simulation of neutron damage should be established. Increased emphasis should be placed on understanding the effects of impurities on the production, migration, and agglomeration of radiation produced defects, particularly the nucleation and growth of voids and dislocation loops. The experimental and theoretical understanding of mechanical properties as they are affected by point defects and their agglomerates, impurities, and defect-impurity combinations should be established. Experimental and theoretical understanding should be established for the dynamic effects of high flux irradiations such as enhanced diffusion, creep, precipitation, and re-solution. To aid the application of basic science to technology, increased university and laboratory cooperation was recommended.

5240 Correlation between blister skin thickness, the maximum in the damage-energy distribution, and projected ranges of He^+ ions in metals: Nb. Kaminsky, M.; Das, S.K.; Fenske, G. (Argonne National Laboratory, Argonne, Illinois 60439). *Appl. Phys. Lett.;* **27**: No. 10, 521-523(15 Nov 1975).

The skin thicknesses of blisters formed on niobium by helium-ion irradiation at room temperature for energies from 100 to 1500 keV have been measured. The projected ranges of helium ions in Nb for this energy range were calculated using either Brice's formalism or the one given by Schiott. For the damage-energy distribution Brice's formalism was used. The measured skin-thickness values corrleate more closely with the maxima in the projected-range probability distributions than with the maxima in the damage-energy distributions. The results are consistent with our model for blister formation and rupture proposed earlier.

CERAMICS, CERMETS, AND REFRACTORIES

PREPARATION AND FABRICATION

5241 (SAND—75-0130) Boron nitride composites by chemical vapor deposition. Pierson, H.O. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 28p. Dep. NTIS $4.00.

Composites of boron nitride (BN) were made by the chemical vapor deposition of a BN matrix on a BN felt fiber substrate. Reactant gases were boron trifluoride and ammonia. The composites had a relatively high density (1.70 g/cm³), a crystallite size L/sub C/ = 150 A, and an interlayer spacing d_{002} = 3.35 A. Measurements of elastic modulus and thermal conductivity and expansion showed some anisotropy as a result of the preferred fiber orientation of the substrate. (7 tables, 5 fig) (auth)

STRUCTURE AND PHASE STUDIES

5242 (KFKI—75-50) Characterization of GGG-substrate surfaces by x-ray topography and etching. Becker, C.; Zsoldos, E.; Vazsonyi, E. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). 1975. 12p. Dep. NTIS (US Sales Only) $4.50.

Application of various x-ray topographic back-reflection methods for $Gd_3Ga_5O_{12}$ (GGG) single-crystal substrates is described and compared with the etching technique. (auth)

5243 (SAND—75-5444) Diffusion and aggregation of implanted Ag and Au in a lithia—alumina—silica glass. Arnold, G.W.; Borders, J.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 14p. (CONF-750926—2). Dep. NTIS $4.00.

From International conference on applications of ion beams to materials; Warwick, UK (9 Sep 1975).

5244 Crystal structure of the ferroelectric phase of $Pb_5Ge_3O_{11}$. Kay, M.I. (Puerto Rico Nuclear Center, Mayaguez); Newnham, R.E.; Wolfe, R.W. *Ferroelectrics;* **9**: 1-6(1975).

The oxygen positions and structure determined for $Pb_5Ge_3O_{11}$ by Iwata, Koizumi, Koyano, Shibuya and Niizeki (J. Phys. Soc. Japan 35, 314 (1973)) were confirmed by an independent refinement of 300 neutron reflections collected using isotropic temperature parameters and a full matrix least squares. It is noted that short lead—oxygen distances and lead site geometry are similar to that found in lead oxides. Germanium takes on its usual tetrahedral coordination. Polarization reversal (and enantiomorphism) may be described by the movement of lead atoms and rotations plus slight translations of GeO_4 tetrahedra to maintain the strong chemical bonds. (auth)

5245 Crystal symmetry of the low temperature phase of magnetite. Iizumi, M.; Shirane, G. (Brookhaven National Lab., Upton, NY). *Solid State Phys.;* **17**: No. 4, 433-436(1975).

A neutron diffraction study of magnetite below the Verwey transition (123°K) reveals that the superlattice reflections are observed for (hhl), with l = integer + $^1/_2$ but not for (hhl). This determines a (110) glide plane in the direction of [001] and implies that only one of the doubly degenerate modes, proposed recently by Yamada, condenses at the transition. (auth)

5246 Transformational superplasticity in the Bi_2O_3—Sm_2O_3 eutectoid system. Smyth, J.R.; Bradt, R.C.; Hoke, J.H. (Pennsylvania State Univ., University Park). Contract AT(11-1)-3420. *J. Am. Ceram. Soc.;* **58**: No. 9-10, 381-384(1975).

From 75. annual meeting of the American Ceramic Society; Cincinnati, OH, USA (1 May 1973).

Transformational superplasticity associated with the eutectoid reaction in the Bi_2O_3-Sm_2O_3 system was observed and characterized in hypoeutectoid and hypereutectoid compositions. Transformational strain varied linearly with applied stress and exhibited a stress-axis intercept, or threshold stress, that is related to the .

proeutectoid microconstituent. Results are explained quantitatively using the analysis by Greenwood and Johnson and a creep mechanism. (auth)

5247 Chemical hysteresis in phase transitions in the TbO—O system. Lowe, A.T.; Eyring, L. (Arizona State Univ., Tempe). *J. Solid State Chem.*; 14: No. 4, 383-394(Aug 1975).

A thermogravimetric study of hysteresis in the TbO/sub x/—O_2 system has provided insight into phase transitions occurring among the fluorite-related rare earth oxides. A series of isobaric scanning loops at 380 torr have been made. The scans were between $TbO_{1.5}$(phi) and $TbO_{1.714}$(l) at higher temperatures and between $TbO_{1.714}$(l) and $TbO_{1.818}$(delta) at lower temperatures. Corresponding isobaric studies were made utilizing high temperature x-ray powder diffraction to augment the TGA experiments. It was confirmed that sections of the lower temperature loop were dependent on the rate of temperature change while the higher temperature loop was entirely reproducible. Interior scanning loops made within the lower hysteresis loop showed univariant behavior typical of a single phase when reversed in the delta'/delta pseudophase region, otherwise it exhibited bivariant behavior. The upper hysteresis loop showed bivariant behavior throughout the interior of the loop. Some thermodynamic aspects and the microdomain concept as applied to hysteresis are also considered. (auth)

5248 Effect of crystal size on chemical hysteresis in praseodymium and terbium oxides. Lowe, A.T.; Lau, K.H.; Eyring, L. (Arizona State Univ., Tempe). *J. Solid State Chem.*; 15: No. 1, 9-17(Sep 1975).

The effect of the variation of crystal size on chemical hysteresis in phase reactions has been investigated by means of thermogravimetric analysis. Series of isobars were followed at several different pressures and crystal sizes for the PrO/sub x/—O_2 and TbO/sub x/—O_2 systems. At higher temperatures the extent of hysteresis decreased with increase in crystal size for both oxides. It was found that equilibrium was not attained in reactions occurring at lower temperatures. These experiments are contrasted with previous investigations using powdered samples. Some plausible explanations for the trends observed are discussed. (auth)

MECHANICAL PROPERTIES

5249 (UCID—16946) **Equations of state for the ceramics BeO and B_4C.** Steinberg, D.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Nov 1975. Contract W-7405-Eng-48. 11p. Dep. NTIS $4.50.

Grueneisen equations of state with a simple constitutive model are described for the ceramics BeO and B_4C. (auth)

5250 Dynamic fracture behavior of Borsic—Al composites. Hoover, W.R.; Allred, R.E. (Sandia Labs., Albuquerque, NM). pp 613-622 of In Dynamic crack propagation. Sih, G.C. (ed.). Leiden; Noordhoff International Publishing (1973).

From International conference on dynamic crack propagation; Bethlehem, Pennsylvania, USA (9 Jul 1972).

See CONF-720709—.

The impact behavior of unidirectional Borsic—Al composites has been studied using an instrumented Charpy system. In order to experimentally determine the most appropriate impact failure criterion for these composites, dynamic load-deflection traces were obtained under plane strain conditions. Specimens with crack length to width ratios (a/W) from 0.15 to 0.65 and crack root radii from 0.002 in. to 0.036 in. were utilized. Results indicated that the dynamic fracture toughness was independent of crack length over an a/W range of from about 0.20 to 0.50 while other fracture criteria such as the dynamic fracture stress, the strain to fracture and the energy absorbed per unit area of fracture surface varied continuously with crack length. Results also indicated that over the range of root radii studied, the dynamic fracture toughness was independent of crack acuity. Consequently, the dynamic fracture toughness appears to be an appropriate impact failure criterion for Borsic—Al composites and has been used to study the effects of the fiber-matrix bond strength and Borsic volume fraction. In addition, the dynamic behavior of these materials has been compared with their behavior during slow bend tests. (auth)

5251 Strength distributions of single filaments. Larder, R.A. (Univ. of California, Livermore). *J. Compos. Mater.*; 9: 241-243(Jul 1975).

A method is described for determining a statistical distribution of strength of glass filaments related to the spacing of flaws in the filament. The procedure consists of dividing the glass filament into arbitrary, equal length, sequential segments. After the entire length of a given filament is processed, its strength is determined by locating the segment with the lowest strength. (JRD)

PHYSICAL PROPERTIES

5252 (CONF-751209—4) **Magnetoelastic interactions in UO_2.** Faber, J. Jr.; Lander, G.H.; Cooper, B.R. (Argonne National Lab., Ill. (USA)). Dec 1975. Contract W-31-109-Eng-38. 9p. Dep. NTIS $4.50.

From 21. annual conference on magnetism and magnetic materials; Philadelphia, Pennsylvania, USA (9 Dec 1975).

Neutron diffraction measurements of the elastic magnetic scattering cross section from antiferromagnetic UO_2 show additional nuclear intensity below T/sub N/ = 30.8°K. An examination was made of the possibility of analyzing the additional scattering in terms of homogeneous distortions, which involve shifts of the oxygen atoms from their fluorite lattice sites. The behavior arising from the presence of these homogeneous distortion modes formed the basis for Allen's theory of a cooperative Jahn—Teller effect in UO_2. However, an analysis in terms of these homogeneous distortions cannot explain the neutron data. But, by extending Allen's concepts to include inhomogeneous deformations, corresponding to a zone boundary q = (π/a) (1,0,0) phonon, excellent agreement is obtained between theory and experiment. The oxygen displacement is 0.014(1) A from the fluorite lattice positions and, in addition, the inhomogeneous deformation (T/sub 2g/(Q^1)—T/sub 1g/) does not require a reduction in the overall symmetry of the unit cell. The essential features of Allen's theory for UO_2 can still be maintained. (auth)

5253 (DP-MS—75-62) **Thermal conductivity of $^{238}PuO_2$ powder, intermediates, and dense fuel forms.** Bickford, D.F.; Crain, B. Jr. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Oct 1975. Contract AT(07-2)-1. 31p. (CONF-751038—1). Dep. NTIS $5.00.

From American Ceramic Society; Seattle, Washington, USA (29 Oct 1975).

The thermal conductivities of porous $^{238}PuO_2$ powder (calcined oxalate), milled powder, and high-density granules were calculated from direct measurements of steady-state temperature profiles resulting from self-heating. Thermal conductivities varied with density, temperature, and gas content of the pores. Errors caused by thermocouple heat conduction were less than 5 percent when the dimensions of the thermal conductivity cell and the thermocouple were properly selected. (auth)

5254 Magnetic moment distribution in uranium dioxide. Faber, J. Jr. (Argonne National Lab., IL). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 51-52(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The magnetic form factor of uranium in UO_2 was examined by means of neutron diffraction. Uranium dioxide (CaF_2 structure) orders antiferromagnetically at 30.8°K with the type I magnetic structure. The intensities of 1250 magnetic Bragg reflections (reducing to 71 independent hkl values and giving full three-dimensional data for sin theta/lambda less than or equal to 0.83 A^{-1}) were measured with a well-characterized stoichiometric single crystal at 5°K. The values of (μf) plotted versus sin theta/lambda show considerable asphericity for sin theta/lambda greater than 0.5 A^{-1}. Comparisons with free-ion (+ crystal field) calculations give an experimental magnetic moment of 1.78 (4) μ/sub B/ and indicate that the general shape of the form factor is in agreement with theory for low scattering angles, but that the nonspherical contributions at higher angles are at least a factor of five greater than expected. The significance of these results is discussed in terms of the extended nature of the 5f wavefunctions in UO_2. (auth)

5255 Magnetism in neptunium borides. Smith, J.L.; Hill, H.H. (Los Alamos Scientific Lab., NM). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 382-383(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Magnetization measurements were performed on NpB_2, NpB_4, and NpB_{12} over the temperature range 2-1802°K. NpB_2 is ferromagnetic below T/sub C/ = 99.5 +—2°K; NpB_4 antiferromagnetic below T/sub N/ = 52.5 +—2°K. These compounds exhibit approximate Curie-Weiss behavior above their ordering temperatures. The corresponding Pu compounds as well as PuB_6 were found not to exhibit magnetic ordering above 2°K. The susceptibility of NpB_{12} is relatively independent of temperature. Attempts to prepare NpB_6 in the arc furnace were unsuccessful. The ferromagnetism of NpB_2 is apparently itinerant in nature, the moment being unsaturable at 52 kOe and 2°K and having magnitude approximately 0.3 μ/sub B/ per Np atom. The very occurrence of magnetism in the compound is somewhat surprising considering the relatively small separation between nearest-neighbor Np atoms in the compound, d/sub Np-Np/ = 3.16 A. (auth)

5256 Electronic conduction in oxides at elevated temperatures. Blumenthal, R.N. (Marquette Univ., Milwaukee). *J. Solid State Chem.*; **12**: 307-318(1975).

A brief discussion of the defect models and experimental techniques used to characterize the electrical conductivity of insulating and semiconducting oxides are presented. Emphasis is on the electronic conduction at elevated temperatures, where the oxide may be equilibrated with the ambient atmosphere. Where appropriate, typical examples of oxides are selected to emphasize (1) how information about defect structures and transport properties of the defects in oxides may be obtained from a combined analysis of different types of experimental data, and (2) some of the experimental and theoretical problems which are limiting the understanding of the electronic conductivity of insulating and semiconducting oxides and their application to technology. (39 references) (auth)

5257 Study of photoluminescence in Cu_2O. Petroff, Y.; Yu, P.Y.; Shen, Y.R. (Univ. of California, Berkeley). *Phys. Rev., B;* **12**: No. 6, 2488-2495(15 Sep 1975).

The photoluminescence spectrum of Cu_2O was studied using a tunable dye laser. It was found that most of the luminescence peaks can be identified as due to recombination of the 1s yellow exciton of Cu_2O or its phonon replica. These phonon replicas showed asymmetric broadening with increase in temperature. A few of the lines showed very strong temperature dependence disappearing rapidly at high temperature. The origins of these lines are still a matter of speculation. The luminescence excitation spectrum of Cu_2O is also presented and interpreted. (auth)

5258 Magnetic susceptibility of $^{243}AmO_2$. Karraker, D.G. (Savannah River Laboratory, E. I. du Pont de Nemours and Company, Aiken, South Carolina 29801). *J. Chem. Phys.;* **63**: No. 7, 3174-3175(1 Oct 1975).

The magnetic susceptibility of $^{243}AmO_2$ from 2.2 to 97 degreeK was measured. The sample showed an antiferromagnetic transition at 8.5plus-or-minus0.5 degreeK and to regions of temperature-dependent paramagnetism above 15 degreeK. (AIP)

CORROSION AND EROSION

5259 (BNWL-SA—5513) **Hydrolysis of uranium carbide fuel beads.** Bunnell, L.R.; Chikalla, T.D.; Woodley, R.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 18p. (CONF-751038—3). Dep. NTIS $4.50.

From American Ceramic Society; Seattle, Washington, USA (29 Oct 1975).

The rate of hydrolysis of bare and defected coated UC_2 fuel bead cores by water vapor was studied over a wide range of temperature and water vapor partial pressures (24—76 torr). Reaction products and nature of the reaction were studied by optical and scanning electron microscopy. The activation energy was determined to be 6.07 +-0.70 kcal/mole. The major gaseous reaction products were identified as C_2H_6, CH_4, and H_2. (17 fig) (DLC)

RADIATION EFFECTS

5260 (DP-MS—75-67) **Helium bubbles at grain boundaries of high-density $^{238}PuO_2$ shards.** McDonell, W.R.; Sheenan, J.E.; Sisson, R.D. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 23p. (CONF-751101—49). Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Hydroxide- and oxalate-base $^{238}PuO_2$ shards that were sintered to high density at 1200 or 1600°C and then aged for 6 months or more exhibited grain-boundary gas bubbles due to agglomeration of alpha-decay helium when heated to 1200°C and above. Conditions for bubble formation depended markedly on shard microstructure; large-grained shards with few large residual sintering pores formed gas bubbles at lower temperatures than small-grained shards with many pores. This behavior was especially apparent in oxalate-base $^{238}PuO_2$, in which small-grained shards resisted bubble formation to above 1500°C; small-grained hydroxide-base shards with less internal porosity than oxalate-base shards formed bubbles at lower temperatures. Helium is apparently released from aged $^{238}PuO_2$ shards at high temperatures by bulk diffusion within grains to the grain boundaries, where bubbles are formed and interconnect into networks which permit helium escape. It is postulated that helium is released by grain boundary diffusion at temperatures below thresholds for grain boundary bubble formation. Small grain size and high residual porosity within grains inhibit the formation of the grain-boundary gas bubbles by reducing the concentration of helium gas at the grain boundaries. (10 fig) (auth)

COMPOSITE MATERIALS

PREPARATION AND FABRICATION

5261 (COO—2407-3) **Generalization of internal centrifugal zone growth of metal-ceramic composites. Progress report, December 1, 1974—August 31, 1975.** Sekerka, R.F. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). 1975. Contract E(11-1)-2407. 14p. Dep. NTIS $4.50.

Objectives are (1) to develop a model of Internal Centrifugal Zone Growth (ICZG) and (2) to use this model to improve present ICZG systems. During the present year, models were developed for finite samples heated by finite induction coils. These models enable calculation of two-dimensional temperature profiles in solid samples. Molten zone shapes can be calculated provided that simplified boundary conditions for the rf field are employed. Experiments to test these models were conducted here and at ORNL. The heating instability phenomenon was possibly observed but not quantified. (DLC)

5262 (LA—6081-PR) **Research on carbon—aluminum composites. Progress report, January 1—June 30, 1975.** Imprescia, R.J.; Levinson, L.S.; Reiswig, R.D.; Wallace, T.C.; Williams, J.M. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. Contract W-7405-ENG-36. 40p. Dep. NTIS $5.00.

A chemical vapor deposition apparatus was constructed for continuously coating graphite fibers with TiC. As much as 150 meters of continuously coated fibers were produced. Deposition temperatures were varied from 1365 to about 1750°K, and deposition time from 6 to 150 s. The 6 s deposition time corresponded to a fiber feed rate of 2.54 m/min through the coater. Thin, uniform, adherent TiC coats, with thicknesses up to approximately 0.1 μm, were produced on the individual fibers of Thornel 50 graphite yarns without affecting fiber strength. Although coat properties were fairly uniform throughout a given batch, more work is needed to improve the batch-to-batch reproducibility. Samples of TiC-coated Thornel 50 fibers were infiltrated with an aluminum alloy and hot-pressed in vacuum to produce small composite bars for flexure testing. Strengths as high as 90 percent of the rule-of-mixtures strength were achieved. Examination of the fracture surfaces revealed that the bonding between the aluminum and the TiC-coated fibers was better than that achieved in a similar, commercially infiltrated material made with fibers having no observable surface coats. Several samples of Al-infiltrated, TiC-coated Thornel 50 graphite yarns, together with samples of the commercially infiltrated, uncoated fibers, were heated for 100 h at temperatures near the alloy solidus. The TiC coated samples appeared to undergo less reaction than did the uncoated samples. (auth)

5263 Screening of epoxy systems for high performance filament winding applications. Chiao, T.T.; Jessop, E.S.; Penn, L. (Univ. of California, Livermore). pp 167-176 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—.

Several promising epoxy systems for high performance filament winding applications are described. Viscosities, gel times, and cast resin tensile behavior are given, as well as heat deflection under load and water absorption measurements. (auth)

5264 Controlled porosity filter and uniform structure composites. Sheinberg, H. (to U.S. Energy Research and Development Administration). US Patent 3,907,513. 23 Sep 1975. Filed date 30 May 1974. 4p.

PAT-APPL-474,547.

Composite materials having controlled porosities were used to fabricate a plurality of screens bonded together in substantially parallel fashion, with the meshes of each screen having spherical particles of a diameter which substantially reduces the size of the openings of the meshes. The porosity of the material is controlled by the offset or rotational orientation of the screens in relation to each other. These materials are particularly useful as filters or controlled flow devices. (auth)

MECHANICAL PROPERTIES

5265 Metal and metal-resin matrix composite pressure vessels. Gerstle, F.P. Jr.; Guess, T.R.; Moss, M. (Sandia Labs., Albuquerque, NM). pp 10-27 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—.

The processing and performance of spherical vessels fabricated from boron or stainless steel filaments in aluminum, aluminum-epoxy, or epoxy matrices were investigated. A previously developed analytical model was used to compare performance of the various vessels through the critical parameters of maximum composite strain and radial strain gradient. Maximum strain of the boron-reinforced vessels was quite consistent, varying from 0.6 percent to 0.8 percent. The impregnated aluminum matrix composite, with its high radial modulus, was the most effective in reducing strain gradients in the vessel walls. (auth)

5266 Elongated-ring specimen for tensile properties of filament-wound composites. Clements, L.L.; Moore, R.L.; Chiao, T.T. (Univ. of California, Livermore). pp 188-201 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—.

The elongated-ring specimen for tensile properties of filament-wound composites is evaluated in terms of its advantages and disadvantages and the significance of test results. The ease of fabrication of the specimen is examined and various means of obtaining strain data are considered. Tensile data from this specimen are presented for several fiber/epoxy composite systems. (auth)

5267 Performance of filament-wound vessels from an organic fiber in several epoxy matrices. Chiao, T.T.; Jessop, E.S.; Hamstad, M.A. (Univ. of California, Livermore). pp 202-216 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—.

A study was carried out to select a state-of-the-art epoxy for wet filament winding. Ten epoxy systems were used to filament wind pressure vessels with a high-modulus, high-strength organic fiber. Data is reported on vessel performance, fiber strand strengths, and shear strengths for the different systems. Using the criteria of processibility, neat resin properties, and vessel performances, it is found that an epoxy system based on the rubber-modified bis-phenol-F resin, diluted with vinyl cyclohexane dioxide and cured with mixed aromatic amines, can easily replace bis-phenol-A epoxies diluted with bis-(2,3-epoxycyclopentyl) ether (such as ERL 2256 epoxy of Union Carbide) with comparable overall performance. (auth)

5268 Fatigue life of organic fiber/epoxy pressure vessels. Hamstad, M.A.; Chiao, T.T.; Patterson, R.G. (Univ. of California, Livermore). pp 217-229 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—.

The cyclic fatigue life of 10.2-cm-dia cylindrical pressure vessels was studied. The vessels were made of an organic fiber/epoxy composite. To determine the typical strength distribution of the vessels, 25 of them were internally pressurized until they burst. Twenty-five vessels were then tested under sinusoidal cycling at 1 Hz between 4 and 91 percent of the mean burst strength. An additional twenty-five vessels were tested between 4 and 91 percent with a rectangular pressure pulse at $^1/_3$ Hz. A limited number of vessels were tested for stress rupture at the 91 percent level. Cyclic life was found to depend on time at peak load as well as the number of stress cycles. (auth)

PHYSICAL PROPERTIES

5269 (SAND—75-5390) **Effective thermal diffusivity for a multi-material composite laminate.** Schimmel, W.P.; Beck, J.V.; Donaldson, A.B. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 27p. (CONF-751106—10). Dep. NTIS $4.50.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

The development of an effective thermal diffusivity is discussed which can be used to estimate the temperature response at the insulated rear surface of a multi-layer composite to a step in temperature at the front surface of the composite. An example is considered using the effective value along with the mathematics of a single layer problem, and results thereof are compared with both those of an exact solution and those which use an effective diffusivity computed from a lumped parameter model. (auth)

5270 Long pot-life epoxy system for filament winding. Penn, L.S.; Chiao, T.T. (Univ. of California, Livermore). pp 177-187 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—.

A long pot life and high strength epoxy resin system suitable for wet filament winding was characterized. The formulation is: diglycidyl ether of bisphenol F/diglycidyl ether of neopentyl diol/ eutectic mixture of m-phenylene diamine and crude methylene dianiline/ 2,6-diaminopyridine (100/30/13.2/13.2). The system has a pot life of 84 h (30 g at 25°C) and a viscosity of 0.85 Pa . s. The long pot life and the low viscosity make it very amenable to the winding of large structures. The cure cycle was optimized with respect to tensile properties: $4^1/_2$ h at 90°C followed by 4 h at 120°C. This produced a resin of high tensile strength (100.6 MPa) and high modulus (3120 MPa). The cured resin was further characterized with respect to solvent absorption, thermal properties, and shrinkage behavior. (auth)

POLYMERS AND PLASTICS

5271 (ANL-Trans—1003) **Use of elastomers in nuclear reactors.** Eude, J.C. Translated from *Rev. Gen. Caoutch. Plast.*; 49: No. 5, 395-401(1972). 12p. Dep. NTIS $4.50.

The principal applications of elastomers in the nuclear reactor domain are: sealing joints, valve flaps, points and coatings, and thermal and electrical insulators. Elastomers having special properties are required for certain applications: applications in the presence of radiations; use in contact with special fluids, e.g., CO_2(EL-4), liquefied Na of Phenix, or demineralized water. Some examples of problems encountered by the CEA are cited: joints of the Phenix plug and the EL-4 plug and incidents that have occurred with the valve flaps in EL-4. (FR)

5272 Self-destruct casting resins. Wischmann, K.B. (Sandia Labs., Albuquerque, NM). pp 447-458 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—.

This report details the development of several encapsulating formulations which were designed as self-destruct and conductive residue materials for controlled destruction of electronic components. These unusual formulations function initially as dielectric potting materials; yet, upon reaching a certain temperature, ignite and self-destruct to a conductive residue which can cause massive shorting. To achieve this response, selected metallic oxides have been incorporated into epoxy resins. The oxide functions as a vigorous oxidizing agent during combustion resulting in the oxide being reduced to the metallic form, the conductive residue. These kinds of formulations have been characterized with respect to mechanical, electrical, combustion, and aging properties; safe handling and processing parameters also have been defined. (auth)

MECHANICAL PROPERTIES

5273 Rubber-modified, low-density encapsulant. Furney, M.F. (Sandia Labs., Albuquerque, NM). pp 386-394 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—.

Inherently brittle polymers have been made more crack resistant and impact resistant by the incorporation of small amounts of a liquid rubber resin. This additive polymerizes separately and emerges as a second discrete phase. This results in the material being "toughened" rather than "plasticized" or "flexibilized." Small glass spheres have been incorporated into this toughened epoxy matrix. Some of the thermomechanical properties of the material are presented and compared to the unmodified resin. (auth)

PHYSICAL PROPERTIES

5274 (UCID—16932) **Dielectric analysis of a room-temperature-cured urethane adhesive.** Althouse, L.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Oct 1975. Contract W-7405-Eng-48. 4p. Dep. NTIS $4.50.

A dielectric technique is described for quantitatively differentiating between secondary transitions and hydrogen-bond dissociations in a room-temperature-cured urethane adhesive. (auth)

5275 Effect of diisocyanate structure on the properties of polybutadiene based elastomers. Arnold, C. Jr. (Sandia Labs., Al-

buquerque, NM). pp 418-432 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—.

The effect of varying the diisocyanate structure of polybutadiene based elastomers was investigated. Improved thermomechanical and adhesive properties were realized when 2,4-toluene diisocyanate (2,4-TDI) was replaced by 4,4'-diphenylmethane diisocyanate (MDI). (auth)

OTHER MATERIALS

5276 (CONF-751121—1) **Testing of coatings for the nuclear industry.** Goldberg, G. (Oak Ridge National Lab., Tenn. (USA)). 1975. 23p. Dep. NTIS $4.50.

From Southeastern regional meeting of the national association of corrosion engineers; Buena Vista, Florida, USA (9 Nov 1975).

Coatings for commercial nuclear power plants need to withstand humidity, radiation exposure, and LOC accident conditions; they also must be decontaminable. Tests for decontaminability, radiation stability, and design-basis-accident (DBA) resistance are described. An irradiation test facility using spent fuel assemblies and a spray loop for simulating a DBA are described. A sample test report sheet is presented. (DLC)

5277 (LBL—4505) **Application of novel NMR techniques to solids and liquid crystals.** Pines, A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 52p. (CONF-750873—1). Dep. NTIS $5.50.

From 2. specialized colloquium; Ampere, Budapest, Hungary (25 Aug 1975).

Techniques for obtaining high resolution nmr spectra of ^{13}C and ^{1}H in ordered phases are described. The latter involves double quantum transitions of the deuterium nuclear spins. Some simple quantitative aspects of these double-quantum processes are discussed. Applications of ^{13}C to hydrogen-bonding in solids and ordering in a nematic liquid crystal are shown and the effects on lineshapes of the ^{13}C resonance due to various kinds of molecular motion in solids and liquid crystals are described. In particular, some weak singularities in the powder spectrum for six-fold motion predicted by Baram, Luz, and Alexander, are computed numerically and verified experimentally. The first determination of the proton chemical shielding tensor in ice by solid state deuterium decoupling is reported and the proton lineshapes obtained between -90 and -5°C in heavy ice are interpreted in terms of proton jumps in a potential with tetrahedral symmetry by motion of defects. (auth)

STRUCTURE AND PHASE STUDIES

5278 (GERHTR—134) **Methods for the characterization of pyrolytic deposited carbon.** Bongartz, K.; Hoven, H.; Koizlik, K. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jun 1974. Translation of JUL—1078-RW. 48p. Dep. NTIS $5.50.

Work Performed Under United States—German High Temperature Reactor Research Exchange Program.

Pyrocarbon is deposited as a coating material on fuel kernels used in HTGRs. For the development of particle coatings specified for various reactor designs, it is necessary to know the properties of pyrocarbon and their changes by neutron irradiation. In this report, procedures are described which are used to characterize pyrocarbon: measurement of geometry, density, microporosity, apparent crystallite size, anisotropy of orientation, modulus of elasticity, and strength of coatings, as well as ceramography, etching by oxidation, secondary and transmission electron microscopy. (auth)

5279 **Perturbed angular correlation of ^{111}Cd/sup m/ in antiferromagnetic MnF_2, FeF_2, CoF_2, and NiF_2.** Rinneberg, H.H.; Shirley, D.A. (Univ. of California, Berkeley). *Phys. Rev., B;* 11: No. 1, 248-255(1 Jan 1975).

The time-differential perturbed angular correlation (PAC) of ^{111}Cd/sup m/ doped into antiferromagnetic MnF_2, FeF_2, CoF_2, and NiF_2 has been observed. The perturbation is caused by a combined electric-quadrupole and magnetic-dipole interaction. The PAC spectra are analyzed using autocorrelation Fourier-transformation techniques. The following quadrupole coupling parameters and internal fields have been observed (4°K). MnF_2: ν/sub Q/ = 16.7 +- 0.2 MHz, eta = 0.05 +- 0.02, H/sub int/ = 34.4 +- 0.8 kOe; FeF_2: ν/sub Q/ = 21.6 +- 0.3 MHz, eta = 0.49 +- 0.02, H/sub int/ = 40.2 +- 0.8 kOe; CoF_2: ν/sub Q/ = 17.7 +- 0.3 MHz, eta = 0.0 +- 0.02, H/sub int/ = 16.4 +- 0.8 kOe; NiF_2: ν/sub Q/ = 16.5 +- 0.3 MHz, eta = 0.1 +- 0.08, H/sub int/ = 24.4 +- 0.8 kOe. The internal fields are perpendicular to the z axis, z/sub FG/, of the field-gradient tensor for MnF_2, FeF_2, and CoF_2, parallel to y/sub FG/ in MnF_2, and pointing along x/sub FG/ in FeF_2. In NiF_2 the internal field is found in the z/sub FG/, x/sub FG/ plane tilted by approximately 48° +- 5° against the z/sub FG/ axis. The hyperfine fields are caused by unpaired spin density transferred into Cd s orbitals from two nearest and eight next-nearest magnetic ions belonging to two different sublattices. The internal fields are compared with those found in the corresponding perovskites $KNiF_3$, $KCoF_3$, $KFeF_3$, and $RbMnF_3$. (auth)

5280 **Spin-3/2 Ising model for tricritical points in ternary fluid mixtures.** Krinsky, S.; Mukamel, D. (Brookhaven National Lab., Upton, NY). *Phys. Rev., B;* 11: No. 1, 399-410(1 Jan 1975).

A lattice-gas model of ternary fluid mixtures is presented. Within the mean-field approximation, a nonsymmetric tricritical point in this model is studied. Results are compared with the experimental observations on the system ethanol-water-carbon-dioxide. Landau theory describing the neighborhood of a fourth-order critical point is studied. It is noted that mean-field theory indicates the existence ofa fourth-order critical point in the spin-1 model of Blume, Emery, and Griffiths, corresponding to K less than 0, J + K greater than 0. (auth)

5281 **Magnetic structure of antiferromagnetic $MnCl_2.4H_2O$.** Altman, R.F. (Georgia Inst. of Tech., Atlanta); Spooner, S.; Landau, D.P.; Rives, J.E. *Phys. Rev., B;* 11: No. 1, 458-461(1 Jan 1975).

The magnetic structure of monoclinic $MnCl_2.4H_2O$ has been determined by analysis of neutron-diffraction data on single crystals. A collinear antiferromagnetic structure was found in which the magnetic and crystallographic unit cells were the same. The Mn^{++} spins were found to point neither along the c axis nor along the c' axis (perpendicular to the ab plane), but in a direction intermediate between the two. (auth)

5282 **Role of consistency effects on the antishielding of nuclear quadrupole moments: comparison between diagrammatic and differential-equation approaches for the ferric ion.** Ray, S.N. (State Univ. of New York, Albany); Lee, T.; Das T.P.; Sternheimer, R.M.; Gupta, R.P.; Sen, S.K. *Phys. Rev., A;* 11: No. 6, 1804-1809(Jun 1975).

A detailed comparison is carried out between consistency contributions to the nuclear quadrupole antishielding factor for the Fe^{+3} ion obtained by the linked-cluster many-body perturbation procedure, as well as a procedure employing perturbed wave functions used in conventional differential-equation procedures for studying antishielding factors. The agreement between results by the two procedures is found to be good, indicating that the procedure using perturbed wave functions is a viable one for studying consistency effects, at least for positive ions. (auth)

5283 **Calculation of the lattice structure on stepped surfaces of Ar and NaCl.** Tsang, Y.W.; Falicov, L.M. (Univ. of California, Berkeley). *Phys. Rev., B;* 12: No. 6, 2441-2447(15 Sep 1975).

Calculations of surface distortions for high-Miller-index stepped surfaces are presented for Ar and NaCl. Negligibly small surface relaxation is found for the Ar surfaces. In the case of NaCl, surface buckling and surface atom displacements on the order of (5 to 10) percent of the atomic step height are obtained. Polarization effects account for the much larger surface distortions in NaCl. (auth)

PROPERTIES

5284 (BNL—20601) **Excitations of substitutionally disordered antiferromagnets.** Cowley, R.A. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 15p. (CONF-751209—15). Dep. NTIS $3.50.

From 21. annual conference on magnetism and magnetic materials; Philadelphia, Pennsylvania, USA (9 Dec 1975).

Measurements by neutron inelastic scattering techniques have provided detailed information about the magnetic excitations of substitutionally disordered antiferromagnets. In the dilute systems, such as MnF_2/ZnF_2, the excitations broaden and decrease in energy with increasing Zn concentration, while in mixed magnetic systems, such as $KMnF_3/KCoF_3$ there are usually two branches of the excitations which correspond to excitations propagating largely on one or other of the magnetic ions. Both of these results are in reasonable accord with the predictions of theories based on the coherent potential approximation and with the results of computer simulations. Recent high resolution experiments on the MnF_2/ZnF_2 system have shown that there is structure in the line shape of the excitations arising from the different excitation energies of Mn ions surrounded by different numbers of Mn neighbors. (auth)

5285 (CEA-CONF—2988) **New components made of organic monomolecular layers.** Barraud, A.; Marc, G.; Messier, J.; Rosilio, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services d'Electronique). Mar 1975. 19p. (In French). INIS.

From International congress on electronic materials; Paris, France (2 Apr 1975).

This study is concerned with electrical properties of aluminium/monomolecular layers/aluminium structures made of n organic layers between 20 and 25 A each, according to the selected molecules. The properties of these layers are reproducible: in vacuo, the capacity is about $1/n\ \mu F/cm^2$, in series with a capacity of $1.5\ \mu F/cm^2$ due to a natural oxide layer at the electrode surfaces. The loss angle tangent in the organic layers (10^{-3}), which is mainly due to dipole movements, is low as compared with that in alumina (10^{-2}). Breakdown voltages are given by the relation V (volts) = 4,5. + 0,75 n. Owing to polymerized monomolecular layers, it was possible to make structures that withstand high temperatures (150°C). (FR)

5286 (CEA-CONF—3028) **Research on the decreased resistance of concrete under traction by detection of stress wave emission.** Despresles, P.J.; Drouet, A.; Tomachevsky, E.G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). 1975. 31p. (In French). INIS.

From Meeting on stress wave emission; Lyon, France (17 Mar 1975).

The recording of the cumulated stress wave emission counting from a concrete specimen under increasing load shows angular points which appear at well-defined fractions of the breaking strength and mark the limits of 4 distinct phases: compression stage for: 0 less than sigma less than 0.2R; assumed micro-cracking phase for: 0.2R less than sigma less than 0.75R; assumed macro-cracking phase for: 0.75R less than sigma less than 0.96R; and prefailure phase for: 0.96R less than sigma less than R. The beginning of the 3rd phase is indicated by an easily identifiable elbow bend which announces impending failure, whereas the specimen shows no apparent external sign of damage. A sample previously loaded under monoaxial compression still keeps an appreciable breaking resistance in traction if the compression has remained below the appearance of this characteristic elbow. Finally the Kaiser effect distinguished by an SWE appearing only above the maximum load previously attained can supply information on earlier loads. (FR)

5287 (ORNL—5050, pp 93-95) **Diffusion of adsorbed species in porous media.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

Results of research on cesium transport in graphite at 600 to 1000°C are reported. Data on cesium penetration in nuclear grade graphites are presented graphically and analyzed. (JRD)

5288 (ORNL-TM—5052) **Time-dependent deformation of concrete under multiaxial stress conditions. Final report.** McDonald, J.E. (Army Engineer Waterways Experiment Station, Vicksburg, Miss. (USA)). Oct 1975. vp. Dep. NTIS $4.00.

For Oak Ridge National Lab., TN.

An investigation was made on the time-dependent deformation behavior of concrete in the presence of temperature, moisture, and loading conditions similar to those encountered in a prestressed concrete reactor vessel (PCRV). This investigation encompassed one concrete strength (6000 psi at 28 days), three aggregate types (chert, limestone, and graywacke), one cement (Type II), two types of specimens (as-cast and air-dried), two levels of temperature during test (73 and 150°F), and four types of loading (uniaxial, hydrostatic, biaxial, and triaxial). This effort was intended primarily as a data report; the experimental procedures and results are presented in detail. A comprehensive evaluation of the effects of various parameters and their interactions on the behavior of concrete is not included. However, a number of general comparisons were made concerning the effect of the various test conditions on concrete behavior. Based on this limited evaluation of the data, general conclusions and recommendations for additional work were formulated. (auth)

5289 (ORNL-TM—5100) **Technique for differentiating between open and closed pores on a microscopic scale.** LaValle, D.E.; Costanzo, D.A.; Lackey, W.J.; Sease, J.D. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 8p. Dep. NTIS $4.00.

A technique was developed that allows differentiation between the closed and open pores of a solid. The technique involves impregnating the open pores with nickel carbonyl gas, decomposing the gas to deposit nickel on the surface of the open pores, and ceramographically observing the deposited nickel. The technique was shown to be applicable to pyrolytic carbon, graphite, stabilized zirconia, alumina, and porcelain. (auth)

5290 (SAND—75-0483) **Adhesive shear strengths: evaluation of the lap shear configuration.** Guess, T.R.; Allred, R.E.; Gerstle, F.P. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 36p. Dep. NTIS $4.00.

5291 (UCID—16934) **Characterization procedure for thermosetting resins.** Penn, L.; Newey, H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Oct 1975. Contract W-7405-Eng-48. 11p. Dep. NTIS $4.50.

A systematic procedure for evaluating thermosetting resins is prepared. By following the procedure, a characterization can be performed that is relevant and comprehensive. Using information gathered from chemical and physical analysis, a quality control specification can be selected. Physical measurements are outlined that can be used to check both the processing factors of the uncured resin and the mechanical and thermal properties of the cured resin. (auth)

5292 (UCRL—51911) **Noncentrosymmetric materials for energy conversion systems: a literature search.** Newkirk, H.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Sep 1975. Contract W-7405-Eng-48. 30p. Dep. NTIS $4.00.

The unclassified literature was reviewed using mainly crystal-chemical search criteria to find potentially useful families of noncentrosymmetric materials that exhibit a broader range of optical, mechanical, and electrical properties than commonly available materials. The materials selected, together with some of their important properties, are summarized in tables. 147 references (auth)

5293 (UCRL—77547) **Long-term performance of fiber composites.** Chiao, C.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Dec 1975. Contract W-7405-Eng-48. 5p. (CONF-751133—1). Dep. NTIS $4.50.

From Proceedings of fly wheel technology; Berkeley, California, USA (10 Nov 1975).

Lawrence Livermore Laboratory has been evaluating the long-term performance of fiber composites for over 6 years. Several years of stress-rupture data for S-glass/epoxy and Kevlar/epoxy composites have been obtained. Other composites are now being studied for the flywheel program. An accelerated test to predict life of composites is also being developed. (auth)

5294 **Vibrational modes of vitreous As_2O_3.** Papatheodorou, G.N.; Solin, S.A. (Univ. of Chicago). *Solid State Commun.*; **16**: No. 1, 5-8(1975).

The positions and polarization properties of seven bands observed in the low temperature Raman and depolarization spectra of vitreous As_2O_3 are successfully calculated using a modified molecular model. Nonnegligible intermolecular coupling must be invoked to account for the other two observed Raman bands. (auth)

5295 **Excitations in a two-dimensional random antiferromagnet.** Birgeneau, R.J. (Bell Labs., Murray Hill, NJ); Walker, L.R.; Guggenheim, H.J.; Als-Nielsens, J.; Shirane, G. *J. Phys., C (London)*; **8**: L328-L333(1975).

Inelastic neutron scattering studies of the magnetic excitations in the planar Heisenberg random antiferromagnet $Rb_2Mn_{0.5}Ni_{0.5}F_4$ at 7°K are reported. Two well-defined bands of excitations are observed. A simple mean-crystal model is found to predict accurately the measured dispersion relations using essentially the pure crystal parameters while the zone boundary energy widths are well-accounted for by an Ising cluster model. Intensities, however, are not properly explained using these simple models. (auth)

5296 **Induced staggered magnetic fields in antiferromagnets.** Alben, R. (CNRS, Grenoble, France); Blume, M.; Corliss, L.M.; Hastings, J.M. *Phys. Rev., B;* **11**: No. 1, 295-299(1 Jan 1975).

Uniform magnetic fields may couple in higher order to the antiferromagnetic order parameter in a large class of compensated antiferromagnets. This coupling is described as an induced staggered field. The general rules which determine when the coupling is allowed by the symmetry of the order parameter are given. The dependence of the coupling on field direction is also discussed. Some implications of these results for the behavior of transition-metal fluorides and for metamagnetic tricritical points are given. In particular it is found that there is no induced staggered field in systems such as $FeCl_2$ while a coupling is expected in $FeCO_3$ and FeF_2, as well as in the recently discussed case of dysprosium aluminum garnet. In all these systems, however, the staggered field should vanish along certain symmetry directions for which metamagnetic tricritical points should exist. (auth)

5297 **Low lying defect mode in $CaF_2:Y^{3+}$.** Campbell, J.A.; Schiff, E.A.; Sievers, A.J. (Cornell Univ., Ithaca, NY). *Phys. Lett.*; **51A**: No. 8, 470-472(5 May 1975).

An absorption line in $CaF_2:Y^{3+}$ at 9.4 cm^{-1} was identified by hydrostatic pressure measurements as a yttrium resonant mode. (auth)

5298 Density fluctuations in molten salts. I. Inelastic neutron scattering from liquid RbBr. Price, D.L. (Argonne National Lab., IL); Copley, J.R.D. *Phys. Rev., A;* 11: No. 6, 2124-2133(Jun 1975).

The density fluctuations in molten salts are being investigated with a combination of neutron-scattering and computer-simulation techniques. Results are given for measurements of the coherent inelastic neutron scattering from molten RbBr at 986°K, in the wave-vector range I less than Q less than 7 A^{-1}. In view of the similarity between the Rb^+ and Br^- ions with regard to size, mass, and neutron scattering length, the scattering function measured in these experiments closely reflects the behavior of the number density fluctuations in the melt, regardless of ion type. (auth)

5299 Strength distributions of single filaments. Larder, R.A. (Univ. of California, Livermore); Beadle, C.W. *J. Compos. Mater.;* 9: 241-243(Jul 1975).

The inverse logarithmic relation of mean strength vs length is not linear but changes slope at a critical fiber length. This note illustrates a method for determining a statistical distribution of strength exhibiting such a change of slope. It is assumed that the material has a small normally distributed variation in strength and that the average spacing between flaws can be described by a single additional Poisson distribution. It was found possible to exactly match the strength vs length variations. (DLC)

5300 Effects of porosity on strength of carbon—carbon composites. Brassell, G.W. (Hughes Aircraft Co., Tucson, AZ); Horak, J.A. *J. Compos. Mater.;* 9: 288-296(Jul 1975).

Filament wound/CVD (Chemical Vapor Deposition) carbon-carbon composites have received considerable attention and application within the past few years because of their desirable characteristics such as high heat of ablation, thermal shock resistance, high strength at elevated temperatures, and chemical inertness. However, poor mechanical properties in the transverse direction have hampered the total effectiveness of these composites in some applications and a study of the effects of porosity on transverse tensile strength of filament wound/CVD carbon-carbon composites has been conducted. Two types of filament wound/CVD carbon-carbon composites were studied. A standard filament wound/CVD carbon composite, and a composite similar to the standard processed composite; but with short chopped carbon fibers sprayed on the substrate during the winding process. Transverse tensile strength, volume fraction of open cell porosity, pore geometry, size, and orientation were determined. A linear relationship was observed for the logarithm of transverse tensile strength as a function of volume fraction porosity. However, a considerable difference in the slopes of the lines for sprayed and unsprayed materials was observed, indicating the effect of a parameter other than volume fraction porosity. This additional parameter is pore size distribution. The transverse tensile strength of filament wound/CVD carbon-carbon composites is drastically reduced by increasing volume fraction porosity. In addition, parameters such as pore size distribution, orientation, and geometry are also important, and should be considered when studying porosity effects. The theoretical model prepared by Brown et al [J. Am. Ceramic Soc. 46:320(1959)] for predicting the strength of polycrystalline materials as a function of porosity (size, geometry and orientation) appears reliable for predicting transverse tensile strength of filament wound carbon-carbon composites. (auth)

5301 Electroreflectance of GaAs and GaP to 27 eV using synchrotron radiation. Aspnes, D.E. (Bell Telephone Labs., Inc., Murray Hill, NJ); Olson, C.G.; Lynch, D.W. *Phys. Rev., B;* 12: No. 6, 2527-2538(15 Sep 1975).

Electroreflectance (ER) spectra of GaAs and GaP, taken by the Schottky-barrier method, exhibit to 27 eV the strong structural enhancement and high resolution characteristic of similar measurements below 6 eV. Above 20 eV, a new set of critical points is observed between the flat valence bands derived from the Ga 3d core levels and the local extrema of the sp^3 conduction bands. The attained resolution, of the order of 100 meV, enables resolution of the spin-orbit splitting of 0.45 eV of the 3d-derived valence bands. The following critical-point energies have been determined in GaAs and GaP, respectively. sp^3 valence conduction: E_1', 6.63 +- 0.05 eV, and 6.80 +- 0.05 eV; $E_1' + \Delta_1'$, 6.97 +- 0.05 eV (GaAs only); E_2'' ($GAMMA_{15}$/sup v/ yields $GAMMA_{15}$/sup c/), 10.53 eV, and 9.38 +- 0.1 eV; E_0''' ($GAMMA_{15}$/sup v/ yields $GAMMA_1$/sup c/), 8.33 +- 0.1 eV, and 10.27 +- 0.1 eV, E_1'', 9.5 +- 0.2 eV, and 10.7 +- 0.2 eV. E_3, E_4, and E_7 structures are observed at 15.1, 16.7, and 17.9 eV in GaAs, and at 14.7, 16.1, and 18.6 eV in GaP. Relative values of 3d core to sp^3 conduction-band matrix elements are estimated for several states and show that the lowest 3d core-level ER structures arise from transitions terminating at the X_1/sup c/ conduction-band minimum. An exciton or core-hole interaction shift of 150 meV for GaP and 200 meV for GaAs is calculated, which indicates that core-hole effects are probably small for these materials. Spectral features with initial structure less than 100 meV in width are observed above 20 eV, showing that broadening effects are much smaller in this energy range than previously believed. (auth)

5302 Thermal conductivity of solid argon. Christen, D.K.; Pollack, G.L. (Michigan State Univ., East Lansing). *Phys. Rev., B;* 12: No. 8, 3380-3391(15 Oct 1975).

Large-grained essentially free-standing crystals of solid argon were formed. Subsequent in situ measurements of the thermal conductivity kappa(T) were made by a linear-flow method, covering a temperature range from the triple point, 83.8°K, to liquid-He temperatures. The low-temperature data were highly reproducible within a single run, and of sufficient density to enable quantitative analysis in terms of current theory for heat transport in insulators at low temperatures. In addition, first-principles calculations of the anharmonic crystal-force contribution to the thermal resistivity were performed, based upon the best-known analytic interatomic-potential models. Results of these calculations indicate that observed deviations from a T^{-1} high-temperature dependence can be quantitatively explained by the effects of thermal expansion on the lattice vibrational frequencies. At the lowest temperatures, kappa is seen to be dominated by defect phonon scattering, including a mechanism of somewhat anomalous behavior. (auth)

5303 Magnetic moment of Se_2. Buechler, A.; Meschi, D.J. (Univ. of California, Berkeley). *J. Chem. Phys.;* 63: No. 8, 3586-3590(15 Oct 1975).

Atoms of the oxygen group form diatomic molecules with a multiplet ground state. Of these, O_2 and S_2 conform to Hund's (b) coupling and have an appreciable magnetic moment, whereas Te_2 is better described as having case (c) coupling with a very small effective magnetic moment. Although the Se_2 molecule is intermediate between these two cases, it is closer to case (c) than to case (b). A method of calculating the magnetic moment and Zeeman effect of a molecule of this series with Hund's case (c) coupling is described and applied to Se_2. The calculations result in a value of 5.97 x 10^{-2} μ/sub B/ for the mean effective moment of the Se_2 molecule at 1000 K in a field of 14 kG. This value was found to be consistent with the results obtained experimentally by the use of a molecular beam deflection technique similar to that of Stern and Gerlach. (auth)

RADIATION EFFECTS

5304 (SAND—75-8640) Absorption induced in optical waveguides by pulsed electrons as a function of temperature, low dose rate gamma and beta rays, and 14 MeV neutrons. Mattern, P.L.; Watkins, L.M.; Skoog, C.D.; Barsis, E.H. (Sandia Labs., Livermore, Calif. (USA)). Oct 1975. Contract AT(29-1)-789. 42p. (CONF-750703—14). Dep. NTIS $5.00.

From IEEE annual conference on nuclear and space radiation effects; Arcata, California, USA (14 Jul 1975).

Three separate studies of radioinduced absorption in glass and plastic waveguides were completed. First, the absorption induced by low dose-rate ^{60}Co gamma rays and ^{90}Sr beta rays was measured and compared with results obtained using higher dose rates. The comparison shows the absorption is independent of dose-rate from 500 rads/day to 10^6 rads/day to total doses of 6 x 10^4 rads. Second, the absorption induced in optical fibers by 14 MeV neutrons was measured. The data were compared with results from ^{60}Co gamma-ray irradiations using calculated values of the neutron ionizing dose as a basis of comparison. The results show that the absorption induced by 14 MeV neutrons at the fluences reported here is determined by the neutron ionizing dose in the spectral region from 400 nm to 1100 nm. Third, the effects of temperature on the transient absorption following pulsed electron irradiation were measured. Predictions from kinetic models for geminate recombination, tunneling, thermal untrapping, and impurity-associated scavenging were compared with the experimental data. The results appear to identify kinetic processes that determine recombination in various irradiated waveguides. (auth)

CHEMISTRY

5305 (UCRL—13586) Application of linear transforms and estimation theory to the analysis of chemical data. Final report, July 1, 1972—June 30, 1973. Brubaker, T.A. (California Univ., Liver-

more (USA). Lawrence Livermore Lab.). 15 Aug 1973. 119p. Dep. NTIS $6.50.

Specific tasks undertaken during the period of July 1, 1972, through June 30, 1973, were continued investigation of linear transforms for use with chemistry data; investigation of Kalman filtering for the analysis of chemistry data; simulation methods for evaluation of chemistry systems; and teaching of three 1-week short courses on signal theory to chemistry department personnel. (LK)

ANALYTICAL AND SEPARATIONS CHEMISTRY

ACTIVATION AND NUCLEAR REACTION PROCEDURES

5306 (DP-MS—75-37) **100 mg ^{252}Cf activation analysis facility at the Savannah River Laboratory.** MacMurdo, K.W.; Bowman, W.W. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 26p. (CONF-751009—2). Dep. NTIS $4.50.

From International nuclear and atomic activation analysis conference; Gatlinburg, Tennessee, USA (14 Oct 1975).

The ^{252}Cf Activation Analysis Facility at the Savannah River Laboratory (SRL) is used routinely for multielement analyses of a wide variety of solid and liquid samples (e.g., metal alloys, fly ash and other airborne particles, rocks, and aqueous and nonaqueous solutions). An automated absolute activation analysis technique, developed to use neutron transport codes to calculate multienergy group neutron spectra and fluxes, converts counting data directly into elemental concentrations expressed in parts per million. The facility contains four sources of ^{252}Cf totaling slightly over 100 mg. A pneumatic "rabbit" system permits automatic irradiation/decay/counting regimes to be performed unattended on up to 100 samples. Detection sensitivities of less than or equal to 400 ppb natural uranium and less than or equal to 0.5 nCi/g for ^{239}Pu are observed. Detection limits for over 65 elements have been determined. Over 40 elements are detectable at the one part per million level or less. Overall accuracies of +- 10 percent are observed for most elements. (auth)

5307 (DP-MS—75-38) **Data reduction in the 100 mg ^{252}Cf activation analysis facility at the Savannah River Laboratory.** Bowman, W.W.; MacMurdo, K.W. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 15p. (CONF-751009—3). Dep. NTIS $4.50.

From International nuclear and atomic activation analysis conference; Gatlinburg, Tennessee, USA (14 Oct 1975).

The automated absolute activation analysis technique developed at the Savannah River Laboratory is based on the ability to predict neutron capture reaction rates from tabulated cross sections and neutron spectra accurately calculated for the 100-mg ^{252}Cf source. A series of computer programs comprises the data reduction system which: (1) reduces the gamma-ray spectra to lists of photopeak energies, areas, and statistical errors for all significant photopeaks, (2) assigns each gamma ray to the appropriate activation product by comparing experimental to tabulated gamma-ray energy, (3) converts each photopeak area into an elemental concentration using the experimental timing data, calculated reaction rates, detector efficiency, and activation product spectroscopic data in the absolute activation master equation. The data reduction system requires about one second of IBM 360-195 CPU time for the conversion of each 4096 channel spectrum into a qualitative and quantitative list of elemental composition. The accuracy of the algorithm is better than +- 15 percent for most elements. (auth)

5308 **Alpha-particle and lithium-ion backscattering: complementary methods for surface analysis.** Tousset, J.; Thomas, J.P.; Cachard, A. (Universite Claude Bernard Lyon, Villeurbanne, France). *Trans. Am. Nucl. Soc., Suppl.;* **21**: No. 3, 11(1975).

From International nuclear and atomic activation analysis conference and 19. annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

5309 **Elemental analysis of water and air solids by neutron activation analysis.** Bate, L.C.; Lindberg, S.E.; Andren, A.W. (Oak Ridge-Holifield National Lab., TN). *Trans. Am. Nucl. Soc., Suppl.;* **21**: No. 3, 20-21(1975).

From International nuclear and atomic activation analysis conference and 19. annual meeting on analytical chemistry in nuclear technology ; Gatlinburg, TN (14 Oct 1975).

5310 **Nondestructive fuel assay of laser targets. II. Photonuclear [D(γ,n)] method.** Caldwell, J.T.; Atwater, H.F.; Farnum, E.H.; Fries, R.J.; Hyder, A.K. (Los Alamos Scientific Lab., N.Mex. (USA)). *Nucl. Instrum. Methods;* **126**: No. 2, 293-297(1 Jun 1975).

CHEMICAL PROCEDURES

5311 (CEA-CONF—3017) **Analysis by differential scanning calorimetry.** Bonjour, E. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Transfert et Conversion d'Energie). 1974. 7p. (In French). INIS.

From Annual meeting on calorimetry and thermal analysis; Rennes, France (9 May 1974).

The principle of the differential scanning calorimetry, the calibration of the instruments used and the suitability of this technique for the measurement of specific heats are discussed. (FR)

5312 (CONF-751150—1) **Separation and analysis of refractory pollutants in water by high-resolution liquid chromatography.** Pitt, W.W. Jr.; Jolley, R.L.; Katz, S. (Oak Ridge National Lab., Tenn. (USA)). 1975. 21p. Dep. NTIS $4.50.

From 1. chemical congress of North American Continent; Mexico City, Mexico (30 Nov 1975).

High-resolution liquid chromatography was applied to the problem of analyzing for refractory organic compounds present at microgram-per-liter levels in various polluted waters. Two different chromatographic systems, which were previously developed for the analysis of the molecular biochemical constituents in human body fluids, were used: one is capable of analyzing for compounds which are uv absorbing and/or oxidizable with sulfatoceric acid; the other is capable of analyzing for carbohydrates. Various aqueous samples, sewage treatment plant effluents, coal-liquefaction experiment liquors, natural waters, and drinking water supplies were collected, concentrated up to 10,000-fold, and then chromatographed. The chromatographic fractions were then subjected to a multiple analytical identification procedure using, in sequence, uv spectrometry, gas chromatography, and mass spectrometry. Many of the separated compounds were subsequently identified; for example, 56 organics were identified and quantified at the microgram-per-liter level in the effluent of a primary sewage treatment plant. In addition, numerous unknown constituents have been characterized with respect to gas chromatographic and mass spectrometric properties. (auth)

5313 (CONF-751150—2) **Determination of chlorination effects on organic constituents in natural and process waters using high-pressure liquid chromatography.** Jolley, R.L.; Jones, G. Jr.; Pitt, W.W. Jr.; Thompson, J.E. (Oak Ridge National Lab., Tenn. (USA)). 1975. 22p. Dep. NTIS $4.50.

From 1. chemical congress of North American Continent; Mexico City, Mexico (30 Nov 1975).

Numerous chloro-organics at microgram-per-liter or less concentrations were detected in and separated from several chlorinated freshwaters as well as chlorinated effluents from sanitary sewage treatment plants. The various water samples were chlorinated with milligram-per-liter concentrations of ^{36}Cl-tagged chlorine, and the resulting chloro-organics were separated using high-pressure, high-resolution anion exchange chromatography. The reaction yields and types of chloro-organics are discussed with respect to several parameters such as chlorinating agent, chlorine concentration, ammonia concentration, and inorganic and organic concentrations and composition. The chlorination yield was estimated to be 0.5 percent of the chlorine dosage under typical reaction conditions for cooling waters of the Kingston Steam Plant (Watts Bar Lake) and 3 percent for cooling waters of the Allen Steam Plant (Mississippi River). Typical disinfection procedures using chlorine result in total yields of about 1 percent for chlorinated sewage treatment plant effluents. (auth)

5314 (MHSMP—75-24K) **Trace ammonia analysis by direct gas chromatography.** Bellamy, H.S. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. 7p. Dep. NTIS $4.50.

A method was sought by which a gas sample could be analyzed directly for trace quantities of ammonia without the need for cryogenic fractionation or other means of ammonia concentration. Such a method has been developed. Gas chromatography of an as-received sample using a Porapak N column and an ultrasonic detector is capable of detecting ammonia down to 150 ppm with an accuracy of +- 10 percent. The method is quite rapid and would lend itself well to analysis of a large number of samples in a short length of time. (auth)

5315 (ORNL-NSF-EATC—15) **Environmental applications of the centrifugal fast analyzer.** Goldstein, G.; Strain, J.E.; Bowling, J.L. (Oak Ridge National Lab., Tenn. (USA)). Dec 1975. Contract W-7405-eng-26. 22p. Dep. NTIS $5.00.

The centrifugal fast analyzer (GeMSAEC Fast Analyzer) was applied to the analysis of pollutants in air and water. Since data acquisition and processing are computer controlled, considerable effort went into devising appropriate software. A modified version of the standard FOCAL interpreter was developed which includes special machine language functions for data timing, acquisition, and storage, and also permits chaining together of programs stored on a disk. Programs were written and experimental procedures developed to implement spectrophotometric, turbidimetric, kinetic (including initial-rate, fixed-time, and variable-time techniques), and chemiluminescence methods of analysis. Analytical methods were developed for the following elements and compounds: SO_2, O_3, Ca, Cr, Cu, Fe, Mg, Se(IV), Zn, Cl^-, I^-, NO_3^-, PO_4^{-3}, S^{-2}, and SO_4^{-2}. In many cases, standard methods could be adapted to the centrifugal analyzer, in others new methods were employed. In general, analyses performed with the centrifugal fast analyzer were faster, more precise, and more accurate than with conventional instrumentation. (auth)

5316 (RDT-F—11-3T(9-75)) **Analytical chemistry methods for metallic core components.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Research and Development). Sep 1975. 56p. RSO.

This standard provides analytical chemistry methods for the analysis of alloys used to fabricate core components. These alloys are 302, 308, 316, 316-Ti, and 321 stainless steels and 600 and 718 Inconels and they may include other 300-series stainless steels. (auth)

5317 (UCID—16952) **Determination of silver in electroplating baths by controlled-potential coulometry.** Harrar, J.E.; Waggoner, M.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Dec 1975. Contract W-7405-Eng-48. 5p. Dep. NTIS $4.00.

A method has been developed for the accurate and precise determination of silver in cyanide electroplating baths. The procedure involves wet ashing an aliquot of solution and then measuring the silver by controlled-potential coulometry (CPC). The precision and accuracy of the method are 0.05 percent and 0.2 percent, respectively. (auth)

5318 **Gas chromatographic analyses of the products obtained on pyrolysis of methane during chemical vapor deposition of carbon.** Noles, G.T.; Lieberman, M.L. (Sandia Labs., Albuquerque, NM). *J. Chromatogr.;* **114**: No. 1, 211-214(12 Nov 1975).

A temperature-programmed gas chromatographic method suitable for the determination of hydrogen, aliphatic compounds, benzene and toluene was described. In order to determine the extent of contamination or oxidation during pyrolysis, the method was also designed to separate air, CO, and CO_2. The two disadvantages of the method were that quantitative data for hydrogen could not be obtained for all chromatograms and separation of acetylene and ethylene was insufficient to yield quantitative results. (JSR)

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

5319 **Nondestructive fuel assay of laser targets. III. Elastic-scattering method.** Jarmie, N.; Lovoi, P.A.; Farnum, E.H.; Fries, R.J.; Young, F. (Los Alamos Scientific Lab., N.Mex. (USA)). *Nucl. Instrum. Methods;* **126**: No. 2, 299-302(1 Jun 1975).

SPECTRAL PROCEDURES

5320 (DP—1384) **Equilibrium distribution of uranyl nitrate between nitric acid and 7.5 vol % TBP.** Thompson, M.C.; Murphree, B.E.; Shankle, R.L. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Oct 1975. Contract AT(07-2)-1. 22p. Dep. NTIS $4.00.

The distribution of nitric acid and uranyl nitrate between aqueous solution and 7.5 vol percent tributyl phosphate in normal paraffin diluent was measured at 23, 45, and 60°C. The data are consistent with behavior expected from theory and with previously published data. The data have been used to design a solvent extraction flowsheet for recovery of enriched uranium. (auth)

5321 (KAPL-P—4041) **Factors that influence an elemental depth concentration profile.** McHugh, J.A. (Knolls Atomic Power Lab., Schenectady, N.Y. (USA)). 1975. 11p. (CONF-751054—1). Dep. NTIS $4.50.

From Mass spec seminar; Honolulu, Hawaii, USA (13 Oct 1975).

The use of secondary ion mass spectrometry in concentration profiling is discussed. Two classes of factors that influence an elemental concentration profile are instrumental effects and ion-matrix effects. Instrumental factors that must be considered are: (1) uniformity of the primary ion current density, (2) constancy of the primary ion current, (3) redeposition, (4) memory, (5) primary ion beam tailing and the nonfocused component, (6) chemical purity of the primary ion beam, and (7) residual gas impurities. Factors which can be classified as ion matrix effects are: (1) the mean escape depth of secondary ions, (2) recoil implantation, (3) molecular ion interferences, (4) primary ion beam induced diffusion of matrix species, (5) nonuniform sputter removal of matrix layers, and (6) implanted primary ion chemical and lattice damage effects. (LK)

5322 (LA—6010) **ALLCAL: an interactive BASIC program for spectrochemical calculations.** Apel, C.T. (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1975. Contract W-7405-eng-36. 18p. Dep. NTIS $4.00.

An interactive program, ALLCAL, has been developed at Los Alamos Scientific Laboratory (LASL) to calculate the results of spectrochemical measurements of impurities in production samples. The program generates a working curve from input data of standard samples to calculate the impurity concentrations. ALLCAL permits use by individuals with minimal programming experience/ it is truly interactive in providing periodic means to edit, modify, and change incorrect data that might have been introduced through various human error factors affecting any computer program, without the need to terminate and reinitialize after such editing. The program can be used as a research tool to manipulate data with minimum effort and eliminates repetitive input data from its operation. It also provides the spectroscopist a comparison mode to evaluate the effect of the use or nonuse of a given internal standard. ALLCAL accepts either optical density or percent transmittance data from photographic plates and films. The program is written in BASIC language for a minicomputer with 28,000 octal words of core memory and has been shown to be adaptable to another computer system with slight modifications. (auth)

5323 (LBL—3975) **Monitoring of groups II and V elements in vapor phase crystal growth processes by optical absorption spectroscopy.** Styer, S.R.; Donaghey, L.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. Contract W-7405-ENG-48. 19p. (CONF-750991—1). Dep. NTIS $4.50.

From 5. international conference on chemistry vapor deposition; Burkinghamshire, UK (21 Sep 1975).

Optical absorption spectroscopy was studied as a technique for monitoring vapor phase crystal growth processes involving group II and V elements. Conditions allowing measurement of component partial pressures and component activities in condensed phases were determined for compounds containing Zn, Cd, As, and P. Optical densities of these elements and of their gaseous mixtures were measured as a function of spectral wavelength and temperature with a high-temperature, uv-visible spectrophotometer. A linear analysis is presented for interpreting optical absorption spectra of multicomponent, gaseous mixtures. Results of applying the method to reactive and equilibrium processes are presented. (auth)

5324 (SAND—75-5472) **Qualitative depth profile analysis of metal hydride films using an ion microprobe mass analyzer.** Perkins, W.G.; Foesch, J.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 10p. (CONF-750863—1). Dep. NTIS $4.00.

From 10. annual conference on microbeam analysis; Las Vegas, Nevada, USA (11 Aug 1975).

Current data acquisition and reduction techniques are described, some of recent depth profiling results are reported, and possibilities of semiquantitative analysis for hydrides are speculated on. (LK)

5325 (UCRL—51945) **Portable microwave spectrometer analyzer for chemical contaminants in air: a feasibility study. Final report.** Morrison, R.L.; Maddux, A.; Hrubesh, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Oct 1975. Contract W-7405-Eng-48. 24p. Dep. NTIS $4.00.

The Lawrence Livermore Laboratory has completed a feasibility study for the construction of a field-portable microwave spectrometer analyzer for chemical contaminants in air. This study has produced a set of design specifications that will result in an instrument capable of analyzing 10 separate gases at the required NIOSH detection limits. The system will use either a YIG-tuned Gunn-effect oscillator or multiple-varactor-tuned Gunn-effect oscillator, and the required stability will be achieved by a new gas absorption line frequency-locking technique. (auth)

5326 Spectroscopic determination of low niobium contents in high-alloy steels. Goryczka, J. *Chem. Anal. (Warsaw);* 19: No. 5, 949-961(1974). (In German).

Nb contents of 0.003 to 0.6 percent in medium- and high-alloy C steels may be determined using high-voltage excitation parameters of 12 kV, 600 pF and O mhenrys. Corrections are made for background effects. For high-alloy steels, an ancillary Fe electrode is used to eliminate the effects of the Fe and alloying elements in the steel. The standard deviation of the results is less than +-0.002 percent Nb for a Nb content of 0.02 percent. (Metals Abstr.)

5327 Analysis of solids: approaching the whole problem. Hulett, L.D.; Dunn, H.W.; Dale, J.M. (Holifield National Lab., Oak Ridge, TN). *Trans. Am. Nucl. Soc., Suppl.;* 21: No. 3, 12(1975).

From International nuclear and atomic activation analysis conference and 19. annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

5328 Ion microprobe analysis of grain boundary impurity segregation in an alloy failure. Christie, W.H.; Smith, D.H. (Oak Ridge-Holifield National Lab., TN). *Trans. Am. Nucl. Soc., Suppl.;* 21: No. 3, 13-14(1975).

From International nuclear and atomic activation analysis conference and 19. annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

5329 Determination of gold, silver, and cobalt in aluminum by flameless atomic absorption spectroscopy. McElhaney, R.J. (Union Carbide Corp., Oak Ridge, TN). *Trans. Am. Nucl. Soc., Suppl.;* 21: No. 3, 14-15(1975).

From International nuclear and atomic activation analysis conference and 19. annual meeting on analytical chemistry in nuclear technology ; Gatlinburg, TN (14 Oct 1975).

5330 X-ray excited-optical luminescence of lanthanides in phosphors prepared from yttrium oxide and iron transition-group oxides: application to the determination of lanthanides in iron and its alloys. DeKalb, E.L.; Fassel, V.A. (Ames Lab., IA). *Anal. Chem.;* 47: No. 14, 2354-2356(Dec 1975).

A series of new phosphors was prepared using yttrium oxide and the oxides of the iron transition group elements. These phosphors when excited by x-ray radiation are strongly luminescent in the visible spectral region if the oxides of the iron-group oxides contain lanthanide elements. These phosphors were used for the determination of several lanthanides at the ppM level in iron and several of its alloys. Results of the determination of Ce, Pr, Nd, and Sm in low alloy steel are given. (auth)

5331 Spectrophotometric determination of iodide and iodine at parts-per-million level as a thiocyanate complex. Clark, B.R. (Oak Ridge National Lab., TN); Skoog, D.A. *Anal. Chem.;* 47: No. 14, 2458-1460(Dec 1975).

A simple method is described for the determination of iodide or iodine in aqueous solutions by the generation and photometric measurement of an iodine thiocyanate complex, $I(SCN)_3^-$, in the presence of excess hydrogen peroxide. Because other halides do not produce serious interferences when present in excesses of several thousandfold, separation from these anions can be avoided in many natural samples. The transition metal ions interfered to varying extents. It is suggested that pretreatment of natural samples with a cation exchange resin could remove interfering cations to acceptable levels. (JGB)

SEPARATION PROCEDURES

5332 (AERE-M—2400) Reverse osmosis separation and concentration of sucrose in aqueous solutions using porous cellulose acetate membranes. Stringer, B.; Terry, H.C. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jul 1975. 26p. Dep. NTIS (US Sales Only) $4.50. UK pounds1.00.

From measurements of the concentration polarization during reverse osmosis treatment of aqueous sucrose solutions, it was possible to predict the variation of permeate flux as a function of sucrose concentration. (auth)

5333 (DP—159) Precipitation of neptunium oxalate and calcination to neptunium oxide. Porter, J.A. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Jul 1961. Contract AT(07-2)-1. 27p. Dep. NTIS $5.00.

Declassified 11 Jun 1975.

Two procedures were developed for the quantitative precipitation of neptunium(IV) oxalate that filters rapidly and is readily calcined to the oxide. In the preferred procedure the oxalate was precipitated at elevated temperature from solutions of low acidity. In the alternative procedure the oxalate was precipitated at room temperature from solutions of higher acidity. Neptunium oxide was prepared by calcining the oxalate at 500°C in a flowing stream of air or nitrogen. (auth)

5334 (UCRL—75899(Rev.1)) Leaching of primary sulfide ores in sulfuric acid solutions at elevated temperatures and pressures. Leach, D.L.; Braun, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Oct 1975. Contract W-7405-Eng-48. 30p. (CONF-750204—2). Dep. NTIS $5.00.

From Annual meeting of the Society of Mining Engineers of AIME; New York, New York, USA (16 Feb 1975).

Laboratory experiments simulating in situ copper recovery from primary sulfide ores in sulfuric acid systems pressurized with oxygen are considered. Copper extraction and acid consumption data are correlated with temperature in the range 50—150°C and quenched pH in the range 0.25—2. Adverse changes in the chemical composition of the leach solution and the formation of gangue-mineral alteration products and secondary sulfides can severely limit the extraction of copper above 90°C. Keeping the pH below the self-buffered value of about 2 and the temperature below about 110°C produces the maximum extraction rates. Forcing the pH too low not only results in excessively high acid consumption but may also limit the extraction of copper at temperatures above 100°C. (auth)

5335 Improved water softening process. Sheppard, J.D.; Thomas, D.G. (to U.S. Energy Research and Development Administration). US Patent Application 533,048. Filed date 25 Feb 1975. 9p.

This invention involves an improved process for softening hard water which comprises selectively precipitating $CaCO_3$ to form a thin layer thereof, increasing the pH of the water to precipitate magnesium as magnesium hydroxide and then filtering the resultant slurry through said layer. The $CaCO_3$ layer serves as a thin permeable layer which has particularly useful application in crossflow filtration applications. (auth)

5336 Elution electrophoresis. Scott, C.D. (to U.S. Energy Research and Development Administration). US Patent Application 548,941. Filed date 11 Feb 1975. 10p.

Colloids and macromolecules are separated by simultaneously carrying out elution and electrophoretic separation processes. (auth)

5337 (ORNL-tr—4036) U(IV) extraction from aqueous HNO_3 solution by quaternary ammonium Hyamine-1622. Schmid, E.R.; Juenger, E. Translated by M. Gerrard from *Radiochim. Acta;* 17: No. 3, 153-158(1972). 16p. Dep. NTIS $4.50.

The distribution of uranium (IV) between aqueous nitric acid solutions and solutions of the quaternary ammonium salt Hyamine-1622 (approximately p-diisobutylphenoxyethoxyethyl-dimethyl-benzyl-ammonium as nitrate), using various organic solvents, is described. Uranium (IV) is well extracted. The influence of a number of factors on the uranium(IV) distribution ratio was investigated systematically. In the organic phases, uranium(IV) was present always as a hexanitrato complex. (auth)

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

5338 (CONF-751212—2) Single crystal neutron diffraction studies of mixed-valence $K_2Pt(CN)_4Br$/sub 0.3//sup ./3.0H_2O, $K_2Pt(CN)$ sb cl%%sub 0.3%%sup .%%3.0H2O, and K/sub 1.75/Pt(CN) /sup ./1.5$H_2$0: new results and a summary. Williams J.M. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 30p. Dep. NTIS $5.00.

From International conference on low lying lattice vibrational models and their relationship to superconductivity and ferroelectricity; San Juan, Puerto Rico (1 Dec 1975).

The present status of the structures of the mixed-valence metal-chain forming compounds $K_2Pt(CN)_4Br_{0.3} \cdot 3.0H_2O$, $K_2Pt(CN)_4Cl_{0.3} \cdot 3.0H_2O$ and $K_{1.75}Pt(CN)_4 \cdot 1.5H_2O$, as determined by neutron and x-ray diffraction studies, is reviewed. New thermogravimetric analysis results are presented which prove that deuterated KCP(Br) normally has water content different from the hydrogenous samples, viz., $K_2Pt(CN)_4Br_{0.3} \cdot 3.2D_2O$ vs. $K_2Pt(CN)_4Br_{0.3} \cdot 3.0H_2O$. The relationship of this finding to the previously reported structural results is discussed in detail. Entirely new findings regarding the non-linear Pt-Pt chain observed in $K_{1.75}Pt(CN)_4 \cdot 1.5H_2OH_2O$ are presented. While superlattice formation is known to occur for $K_2Pt(CN)_4Br_{0.3} \cdot 3(H/D)_2O$, no such findings have as yet been observed for cation deficient $K_{1.75}Pt(CN)_4 \cdot 1.5H_2O$, K(def)TCP. Whereas KCP(Br) and KCP(Cl) are disordered by vir-

tue of the halide ion non-stoichiometry, K(def)TCP is fully stoichiometric because it contains a full four formula units per unit cell. (auth)

5339 (JINR—R-12-7440) **Search for the regularities in the change of physical-chemical properties of elements-homologs and their compounds. I. Normal boiling points of halogen compounds.** Kolachkovski, A.; Norseev, Yu.V.; Nefedov, V.D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1973. 20p. (In Russian). INIS.

9 refs.

Differential elastic scattering cross sections with well resolved quantum oscillations have been measuremed for the systems H_2+NH_3 and H_2+H_2O. Assuming a spherically symmetric interaction the data show that a simple spherical potential (i.e. Lennard-Jones) does not properly describe the scattering. (FR)

5340 (JUL—957-PC) **Evaluation of motion pictures for kinetic absorption spectrometry.** Kamat, M.F.; Roeth, E.P.; Schindler, R.N. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Physikalische Chemie). Jun 1973. 22p. (In German). Dep. NTIS (US Sales Only) $4.50.

The effect of the finite illumination time and the limited resolving power on kinetic measurements with motion pictures was studied. For both first- and second-order reactions the error from the finite illumination time is large at high optical densities and long illumination times in relation to the reaction duration. Whereas in first-order reactions these errors lie after a short time in the order of magnitude of the usual measurement errors, in second-order reactions tolerable errors occur only when the half-value time of the reaction is large with respect to the illumination time. A possible method for the correction of the errors caused by the limited resolving power is indicated. (tr-auth)

5341 (LBL—3294) **Comparison of density and temperature measurement using Raman scattering and Rayleigh scattering.** Robben, F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 29p. (CONF-750569—1). Dep. NTIS $4.50.

From Workshop on combustion measurements in jet propulsion systems; Lafayette, Indiana, USA (22 May 1975).

Calculations of the performance, in terms of the signal-to-noise ratio, for vibrational Raman and Rayleigh scattering measurements under combustion conditions are made. The assumed conditions are (1) a hydrogen-air flame at 2000°K, (2) a 1-watt argon-ion laser, and (3) f/5 scattered radiation collection optics. Based on photo-electron counting statistics, the Rayleigh scattering technique has much larger signal-to-noise ratio than Raman scattering, but either technique will give good results for mean temperature and density. However, for the measurement of a nominal 10 percent rms turbulent intensity, only Rayleigh scattering is capable of a satisfactory measurement. It is noted that by use of higher powered lasers and lower f/number light collection optics, Raman scattering should give some information on turbulent fluctuations, especially in the case of turbulent diffusion flames where the fluctuations are of a very large amplitude. (auth)

5342 (LBL—3929) **Ellipsometry of mass-transport boundary layers.** Muller, R.H.; Smith, C.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-ENG-48. 21p. (CONF-750993—1). Dep. NTIS $4.50.

From 3. international conference on ellipsometry; Lincoln, Nebraska, USA (23 Sep 1975).

The effect of mass-transport boundary layers, often associated with surface reactions proceeding at high rates, on ellipsometer measurements of the underlying surface was investigated for typical transport conditions in liquids. The effect can be of significant extent and depends primarily on concentration difference across the boundary layer, angle of incidence, and optical constants of the surface. A simplified method for predicting boundary-layer effects based on light refraction is introduced. Computations are in good agreement with experiments. 7 figures, 3 tables (auth)

5343 (LBL—3955) **Topics in physical chemistry: magnetic properties of oxygen, mixed electrolyte solutions, and pseudorotation in MX_5 molecules.** Kim, J.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1975. Contract W-7405-Eng-48. 161p. Dep. NTIS $7.75.

Thesis.

A small amount of paramagnetic substance such as oxygen has been found to facilitate nuclear-spin-species conversion in solid methane in the low temperature phase (1 to 20°K). In this work the nature of the oxygen molecule in a methane lattice and the magnetic properties of oxygen in relation to its role as a catalyst in the conversion of methane nuclear-spin-species have been investigated. The thermodynamic properties of mixed electrolytes have been studied for only a small number of systems. A primary objective in this work is the prediction of the thermodynamic properties of mixed aqueous electrolytes at concentrations of practical importance by equations of minimum complexity. In a recently reported theory, the nature of the axial-equatorial interchange potential for MX_5(D/sub 3h/ molecules had been proposed. The potential, obtained by considering a pseudo-Jahn—Teller effect coupling the ground and excited electronic states, was also found to describe the potential about the equatorial bending mode for these molecules. (LK)

5344 (SAND—75-0513) **Stability studies of H_2—F_2—O_2 mixtures at pressures above one atmosphere.** Truby, F.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 41p. Dep. NTIS $4.00.

The short-term stability measurements of H_2--F_2--O_2 mixtures at near-room temperatures were carried out using an explosion-cell geometry that is similar to the geometry used for the Sandia electron-beam-initiated high-pressure HF laser study. Using an explosion cell designed to withstand pressures of 400 atm, mixing studies were conducted with varying amounts of oxygen, fluorine, and hydrogen in order to establish criteria for gas mixtures that will remain stable for time periods of approximately 15 minutes. Observed explosion-limit pressures of F_2 and H_2 were determined as a function of oxygen pressure. Data concerning the removal of H_2--F_2--O_2 mixtures from the explosion cell suggests that stability during removal of such mixtures is related to pump-out rates. The cause of certian unexpected detonations is also discussed. Gas mixtures containing H_2, F_2 and O_2 were prepared with total gas pressures of about 10 atm. In certain cases, F_2 pressures used were greater than 4000 torr. These fill pressures are greater by an order of magnitude than those previously reported in the literature. (auth)

5345 (UCRL—76889) **Methylation of platinum by methylcobalamin.** Taylor, R.T.; Hanna, M.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Sep 1975. 32p. (CONF-750929—3). Dep. NTIS .

From 15. symposium on the biological implications of metals in the environment; Richland, Washington, USA (29 Sep 1975).

Incubation of μM levels of K_2PtCl_4 and methylcobalamin (MeB-12) results in the complete conversion of MeB-12 to aquoB-12. Demethylation is optimal at approximately pH 2.0 and is accelerated by the addition of K_2PtCl_4. The reaction is stoichiometric between MeB-12 and the K_2PtCl_4 added (1:1). Isosbestic points at 492 nm, 367 nm, and 335 nm during the course of the reaction indicate that MeB-12 is demethylated to aquoB-12 with no accumulation of corrinoid intermediates. Higher alkylcobalamins and Mecobinamide react at much slower rates compared to MeB-12. When 50 μmoles each of [Me-^{14}C]MeB-12 and K_2PtCl_4 were reacted and subjected to Sephadex G-15 chromatography the ^{14}C-label eluted with 260 nm absorbing material. Further chromatography on Sephadex G-15 and CM-cellulose yields a labeled uv-absorbing product with ^{14}C/Pt ratio of 1.2. Overall recovery was 36 to 42 percent based on the ^{14}C. The ^{14}C-Pt product has absorption maxima at 260 nm and 208 nm with a minimum at 240 nm (A_{240} nm/A_{260} nm = 0.5). Proton NMR spectroscopy confirmed the presence of an H-C-Pt covalent bonding pattern (J for ^{1}H, ^{195}Pt = 78.2 Hz; tau for ^{194}Pt-Me + ^{196}Pt-Me = 6.956). This Me-Pt compound is somewhat light-sensitive; however, its moderate stability in aqueous solutions to NaCl, temperature, and pH suggest that it could have biological activity. (auth)

5346 **X ray photoemission molecular orbitals of hydrogen fluoride and the fluorinated methanes.** Banna, M.S.; Mills, B.E.; Davis, D.W.; Shirley, D.A. (Univ. of California, Berkeley). *J. Chem. Phys.*; **61**: No. 11, 4780-4786(1 Dec 1974).

The x-ray photoemission molecular orbital spectra of gaseous hydrogen fluoride and the fluorinated methanes (CH/sub n/F/sub 4-n/, 0 greater than or equal to n greater than or equal to 4) are reported. Ab initio, Koopman's theorem energies and a three-parameter relaxation model were used to fit the experimental binding energies. Excellent agreement was obtained. Relative intensities of molecular orbitals were computed using the model of Gelius with both CNDO/2 and ab initio atomic populations. In the case of ab initio results, net populations were found to be superior to gross populations in reproducing the experimental intensities. In most cases, the theory predicted intensities quite well. Some trends exhibited by the fluoromethane series are noted. (auth)

5347 **Electronic structure and chemical dynamics.** Mahan, B.H. (Univ. of California, Berkeley). *Acc. Chem. Res.*; **8**: 55-61(1975).

It is shown how, by using the known electronic properties of reactants, products, and intermediates, much of the dynamical behavior of these simple systems can be understood. The noble gas--hydrogen, C^+--H_2, and N^+--H_2 systems are used as illustra-

tions. Electronic state correlation diagrams are used to deduce the qualitative nature of the potential surfaces which control the reaction dynamics. The value of making electronic state correlations and illuminating them by orbital correlations is demonstrated. (JSR)

5348 ^{121}Sb Moessbauer studies on antimony(III) chalcogenohalides. Donaldson, J.D. (Univ. of London); Southern, J.T.; Kjekshus, A.; Nicholson, D.G. *Acta Chem. Scand., Ser. A;* **29**: No. 2, 220-224(1975).

^{121}Sb Moessbauer spectra of SbSBr, SbSeBr, SbSI, SbSeI , and SbTeI were obtained at 4.2°K and are discussed in relation to available structural data. A remarkable feature of the iodides is that the quadrupole coupling constant decreases in the order SbSI greater than SbSeI greater than SbTeI, becoming negative for the latter. (auth)

5349 Kinetics of the mercury(II) catalyzed isomerization and aquation of the thiocyanatopentaammminecobalt(III) ion. Adegite, A.; Orhanovic, M.; Sutin, N. (Brookhaven National Lab., Upton, NY). *Inorg. Chim. Acta;* **15**: 185-190(1975).

Mercury(II) reacts with the $Co(NH_3)_5SCN^{2+}$ ion to form $Co(NH_3)_5scn.hg$ $^{4+}$which undergoes aquation and isomerization to yield $Co(NH_3)_5H_2O^{3+}$ and $Co(NH_3)_5NCSHg^{4+}$. The stability constant of the binuclear complex is 1.2 M^{-1} and the corresponding ΔH_0 and ΔS_0 values are -5.2 kcal $mole^{-1}$ and -17 cal $mole^{-1}$ K^{-1}, respectively, at μ = 1.00M and 25°C. Rate parameters k = 0.23 s^{-1} at 25°C, ΔH^{2+} = 21.4 kcal mol^{-1}, and ΔS^{2+} = 10 cal mol^{-1} K^{-1} were obtained for the aquation and isomerization of the binuclear complex. The two cobalt(III) products are formed at approximately equal rates. The mechanism of the reaction is discussed in terms of the formation of a common intermediate in the isomerization/aquation processes. (auth)

5350 Mutual diffusion coefficients of aqueous $ZnSO_4$ at 25°C. Albright, J.G.; Miller, D.G. (Univ. of California, Livermore). *J. Solution Chem.;* **4**: No. 9, 809-816(1975).

Diffusion coefficients of the system $ZnSO_4$-H_2O at 25°C were measured using Rayleigh optics from 0.004 to 3.33 m. The results appear to extrapolate with reasonable agreement to the data of Harned and Hudson at very low concentration. The diffusion coefficients decrease from 0.8486 x 10^{-5} at 0 m to 0.2813 x 10^{-5} cm^2-sec^{-1} at 3.33 m. Densities were measured over the concentration range 0.10 to 3.60 m and combined with the data of Geffcken and of Gibson to obtain an analytical expression for density over the concentration range 0 less than or equal to m less than or equal to 3.6. (auth)

5351 Auger electron spectrum and ionization potentials of the HF molecule. Shaw, R.W. Jr. (Univ. of Oregon, Eugene); Thomas, T.D. *Phys. Rev., A;* **11**: No. 5, 1491-1497(May 1975).

The Auger electron spectrum of HF in the gas phase has been measured and the peaks identified with the transitions to the expected final states in HF^{++}. The relative energies and intensities are similar to those for the Auger spectrum of the isoelectronic atom neon. The additional features appearing in the HF spectrum are explained in terms of perturbations to Ne^{++} or F^- by an adjacent proton. The ionization potentials of HF have been measured by photoelectron spectroscopy. The energy-loss spectrum for 710-eV electrons incident on HF has been determined and the peaks identified with the expected excited states in the HF molecule. (auth)

5352 Calculated and experimental electronic structure of gaseous MnO_3F and MnO_3Cl. Jasinski, J.P. (Univ. of Wyoming, Laramie); Holt, S.L.; Wood, J.H.; Moskowitz, J.W. *J. Chem. Phys.;* **63**: No. 4, 1429-1444(15 Aug 1975).

The gas phase electronic absorption spectra of MnO_3F and MnO_3Cl were measured in the visible and near ultraviolet regions. Interpretation was made by comparison with a molecular calculation for each molecule by the SCF—Xα—SW method in terms of C/sub 3v/ symmetry. The calculated ground and excited states and observed electronic transitions correlate directly with those for the parent MnO_4^- cluster. The lowest excited state, ^{1}E/sup a/, which correlated with the first $^1T_1$ state of MnO_4^-, retains the characteristics of the parent state. The charge transfer originating from the halide atom is first observed in the ^{1}E/sup c/ excited state in each molecule correlating with the second lowest $^1T_2$ state in MnO_4^-. (auth)

5353 Normal coordinate treatment of XeO_3F_2. Willett, R.D. (Washington State Univ., Pullman); LaBonville, P.; Ferraro, J.R. *J. Chem. Phys.;* **63**: No. 4, 1474-1478(15 Aug 1975).

A normal coordinate treatment (NCT) using a modified Urey—Bradley force field (MUBFF) was made for XeO_3F_2. New analyses were also performed on $XeOF_4$ and XeO_2F_2. Force constants obtained were compared with force constants from other xenon compounds containing fluorine and/or oxygen atoms. In general, as oxygen atoms are added to XeF_2 the bond distance of the Xe—F decreases while the K/sub XeF/ force constant increases, and the Xe—O bond distances increase while the K/sub XeO/ force constant decreases. (auth)

5354 Pressure-broadened linewidths of ozone. Tejwani, G.D.T.; Yeung, E.S. (Ames Lab., IA). *J. Chem. Phys.;* **63**: No. 4, 1513-1517(15 Aug 1975).

Self-broadened and foreign-gas (N_2 and O_2) broadened linewidths of O_3 at 300°K for a wide range of quantum numbers J and K/sub a/, for both type A and type B bands, have been calculated using the Anderson—Tsao—Curnutte theory of line broadening. In the case of O_3—O_3 collisions, dipole—dipole, dipole—quadrupole, quadrupole—dipole, and quadrupole—quadrupole interactions have been included. For O_3—N_2 and O_3—O_3 collisions, dipole—quadrupole and quadrupole—quadrupole interactions were taken into account. Good agreement was obtained between the available measured linewidths and the computed values for corresponding transitions on using the molecular quadrupole moments of O_3 given by Rothenberg and Schaefer. Air-broadened linewidths of O_3 at 200°K have also been computed, so that the temperature dependence can be established. (auth)

5355 Approximate solution of the adiabatic explosion problem. Smith, L.C. (Los Alamos Scientific Lab., NM). *Thermochim. Acta;* **13**: No. 1, 1-6(Sep 1975).

The accuracy of a simple, well-known approximation to the solution of the adiabatic explosion problem was examined. It was found that, with a minor modification, the approximation can be converted to a form accurate to 1 percent or better for a wide range of the input parameters. The final result lies well within the capabilities of even the simplest scientific calculators. The effects of depletion of the reactant and a temperature-dependent heat capacity, not included in the development, are briefly evaluated. (auth)

5356 Apparent and partial molal heat capacities of some aqueous rare earth chloride solutions at 25°C. Spedding, F.H.; Walter, J.P.; Baker, J.L. (Ames Lab., IA). *J. Chem. Eng. Data;* **20**: No. 4, 438-443(Oct 1975).

Specific heats of aqueous solutions of the stoichiometric trivalent Pr, Sm, Eu, Gd, Tb, Ho, Tm, and Lu chlorides were measured over the concentration range of 0.1 m to saturation at 25°C. Apparent molal heat capacities, phi/sub cp/, were calculated for these solutions, and empirical polynomial equations were obtained which expressed phi/sub cp/, within experimental accuracy, as a function of m/sup $^1/_2$/ for each salt. From these equations the partial molal heat capacities of the solvent, C/sub p1/, and the solute, C/sub p2/, were calculated. Together with earlier reported data on five other rare earth chlorides, the C/sub p1/ data at even molalities exhibited a two series effect across the rare earth series over the whole concentration range, similar to the rare earth perchlorate data. The differences in the concentration dependence of the heat capacity properties between rare earth chloride and rare earth perchlorate solutions are discussed in terms of ion-ion and ion-solvent interactions. (auth)

5357 Dc conductivity of tetrathiofulvalene bromide (TTF-Br/sub n/) and TTF-I/sub n/ single crystals. Warmack, R.J. (Univ. of Tennessee, Knoxville); Callcott, T.A.; Watson, C.R. *Phys. Rev., B;* **12**: No. 8, 3336-3338(15 Oct 1975).

Tetrathiofulvalene (TTF) combines with the halogens to form crystals with interesting electrical properties due to the segregated stacking of the TTF molecules. The monoclinic forms of TTF-I/sub n/ and TTF-Br/sub n/ (n approximately 0.7) have a high conductivity [100-550 (Ω cm)$^{-1}$] which is almost temperature independent for a very broad region near room temperature but display a thermally activated conductivity at low temperature. Unlike monoclinic TTF-Br/sub n/, monoclinic TTF-I/sub n/ displays a strong hysteresis in its conductivity upon temperature cycling. The conductivity of the orthorhombic form of TTF-I/sub n/ (n = 2) is about five orders of magnitude lower than the monoclinic form at room temperature and is thermally activated over the entire temperature range. (auth)

5358 Electronic structure of nitrogen dioxide. I. Multiconfiguration self-consistent-field calculation of the low-lying electronic states. Gillispie, G.D. (Michigan State Univ., East Lansing); Khan, A.U.; Wahl, A.C.; Hosteny, R.P.; Krauss, M. *J. Chem. Phys.;* **63**: No. 8, 3425-3444(15 Oct 1975).

Traditional spectroscopic analysis of the complex and irregular absorption spectrum of NO_2 has provided a relatively small amount of information concerning the nature of the excited states. An extensive ab initio investigation has been undertaken, therefore, to provide a basis for interpretation of the experimental

results. Multiconfiguration self-consistent-field (MC-SCF) wavefunctions have been computed for the low-lying X^2A_1, A^2B_2, B^2B_1, C^2A_2, $^4B_2$, $^4A_2$, and $^2\Sigma^+$/sub g/ electronic states of NO_2. (auth)

5359 Kinetic model for clustering of water on hydrated protons in a supersonic free jet expansion. Searcy, J.Q. (Sandia Labs., Albuquerque, NM). *J. Chem. Phys.*; **63**: No. 10, 4114-4119(15 Nov 1975).

A simple model with three variable parameters is developed for calculating observed clustering data from a free jet expansion. One parameter, sigma/sub R1/, can be associated with a reactive collision diameter for a monomer associating with a cluster to form a larger, excited cluster. A second parameter, sigma/sub R3/, can be associated with a reactive collision diameter for energy transfer from the excited cluster to the surrounding gas. The third parameter, K′, is a constant in a unimolecular decay rate expression for the excited cluster. The reactive cross sections that give the best fit of experimental data are given by $(\pi/4)\text{sigma}^2\text{/sub R1/} = 9.90 \times 10^{-16}$ cm² and $(\pi/4)\text{sigma}^2\text{/sub R}_3\text{/} = 5.22 \times 10^{-17}$ cm². No value could be assigned to K′. Apparently the excited clusters are stabilized by energy exchange collisions in this particular flow field before there is appreciable unimolecular decay. Good fits of clustering data are obtained even though these same values are used for clusters varying in size from 6 to 26 water molecules. Since the clustering environment is radically different than in near-equilibrium experiments, it is not clear that these numbers can be used with other types of experimental data. (auth)

ISOTOPE EFFECTS

5360 Hydrogen abstraction reactions by atomic fluorine. III. Temperature dependence of the intermolecular kinetic isotope effect for the thermal F+H_2 reaction. Grant, E.R.; Root, J.W. (Department of Chemistry and Crocker Nuclear Laboratory, University of California, Davis, California 95616). *J. Chem. Phys.*; **63**: No. 7, 2970-2979(1 Oct 1975).

The intermolecular kinetic isotope effect for the title reaction has been investigated using a moderated nuclear recoil technique. The following Arrhenius temperature dependence was obtained: k)2/k)2 = (1.04plus-or-minus0.06)exp(382plus-or-minus35)/RT. This result is in quantitative agreement with an independent study based upon a discharge flow reactor method. The advantages and limitations of the nuclear recoil procedure are considered, and relevant literature results are critically reviewed.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

5361 Separation of sulfur isotopes by liquid thermal diffusion and by chemical exchange. Rutherford, W.M.; Roos, W.J. (Mound Lab., Miamisburg, OH). pp 295-304 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The application of separated sulphur isotopes as environmental tracers depends upon their cost. Sulphur isotopes can be separated in quantities of several kilograms per year by liquid thermal diffusion and by the SO_2-bisulphite chemical exchange process. Mound Laboratory is developing both of these processes. Some of the basic problems associated with liquid thermal diffusion have been solved, and an experimental cascade using carbon disulphide as the working fluid is now being used to separate small quantities of material enriched to more than 45 percent sulphur-34. Chemical exchange appears to be a better method of separating sulphur-34. A 5 column chemical exchange cascade using the bisulphite process is now being constructed. The chemical exchange system will be capable of producing 1.2 kg/a of sulphur at an enrichment of 90 percent sulphur-34. Because of the anticipated cost of sulphur isotopes, applications will be limited to small amounts of enriched material. Double tagging of selected compounds may increase the range of usefulness. (auth)

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

5362 (AECL—5022) Calculation of sedimentation coefficients in linear sucrose gradients. Holford, R.M. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Jul 1975. 21p. Dep. NTIS (US Sales Only) $4.50. AECL $1.00.

A solution is presented to the problem of calculating the sedimentation coefficient of a macromolecule from an observation of the distance through which it sediments in a linear concentration gradient of sucrose when centrifuged for a known time. Empirical functions are used to express the viscosity and density of sucrose, which determine the rate of sedimentation, as functions of concentration. A simple formula is given for integrating the inverse of the rate function to give the required relationship between distance and sedimentation coefficient. The maximum error of the approximations is about one part in a thousand, so that in most cases the accuracy of the results will be limited only by the precision of the physical measurements. The method is well suited for use with a programmable desk calculator, and a complete listing is given of a program implementing the method on a Hewlett—Packard calculator, model 9820. (auth)

5363 (BDX—613-1301(Rev.)) Evaluation of TPX molding resin. Walter, C.L. (Bendix Corp., Kansas City, Mo. (USA)). Oct 1975. Contract AT(29-1)-613. 15p. Dep. NTIS $4.00.

A methylpentene polymer (TPX) was evaluated for possible low density applications because this material has a specific gravity of 0.80 g/cm³. Rheological properties were evaluated and physical characteristics were determined. Thermal analyses data were used to determine that the softening point was 93.5°C and that decomposition begins at 290°C. The material was produced by ICI Limited in Herts, England, but the process has since been acquired by the Mitsui Corporation, Japan. Nine experimental lines (different sets of conditions) were molded to statistically evaluate the combinations of molding variables. Two variables, melt temperature and mold temperature, each had five levels of variance. All other molding conditions were held constant. TPX can be molded successfully under a wide range of conditions. Its major features include high transparency and low specific gravity (0.83 to 0.85). Its physical strengths are like those of high-density polyethylene except that it will shatter upon impact. The heat distortion temperature of TPX is about 130°C, which is far greater than that of polyethylene and about 20°C higher than that of polypropylene. A major drawback is its high mold shrinkage and high differential mold shrinkage. Precision injection molded parts would be very difficult to produce. (auth)

5364 Synthesis and characterization of 3-bromo-1,4-dihydroxy-2-butanone 1,4-bisphosphate, a potential affinity label for enzymes that bind sugar bisphosphates. Hartman, F.C. (Oak Ridge National Lab., TN). *J. Org. Chem.*; **40**: No. 18, 2638-2642(5 Sep 1975).

3-Bromo-1,4-dihydroxy-2-butanone 1,4-bisphosphate, a compound that can be considered a reactive analog of several sugar bisphosphates, was synthesized as a potential affinity labeling reagent for enzymes whose substrates are sugar bisphosphates. The starting material for the synthesis is the commercially available cis-2-butene-1,4-diol. The immediate precursor to the reactive reagent, the corresponding diethyl ketal, is obtained as a crystalline triscyclohexylammonium salt. The stability of 3-bromo-1,4-dihydroxy-2-butanone 1,4-bisphosphate at pH 4-10 was determined by measuring the release of both bromide and P/sub i/. Even at pH 4.0 the reagent is unstable, and at pH 10.0 the release of bromide is complete within 3 hr. Studies with free amino acids, glutathione, and N-α-acetyl-L-lysine indicate that of the functional groups found in proteins, sulfhydryl is the most rapidly modified by bromobutanone bisphosphate. Modification of amino groups by the reagent was also demonstrated, but at a much slower rate. The compounds resulting from the reactions of glutathione and N-α-acetyl-L-lysine were reduced with tritiated sodium borohydride and hydrolyzed with 6 N HCl; the hydrolysates were analyzed on an amino acid analyzer to provide chromatographic markers for future studies involving bromobutanone bisphosphate as a protein reagent. (auth)

5365 (LBL—3122) Oxygen-17 NMR studies of the rate of water exchange from partially complexed nickel ion. Rowland, T.V. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1975. Contract W-7405-Eng-48. 82p. Dep. NTIS $5.00.

Thesis.

The oxygen-17 bulk water NMR linewidth and chemical shifts for an aqueous solution of the nickel iminodiacetate complex, NiIDA, have been measured from 0°C to 140°C at 8.134 MHz in order to determine both the rate of chemical exchange between the two chemically non-equivalent first coordination sphere sites and the bulk solvent and also the scalar coupling constants, A/h. Linewidth measurements from 0°C to 100°C for a $Ni(IDA)_2^{2-}$ sample yielded estimates of the percent time of dissociation for a carboxylate arms and the resulting rate of water exchange. (auth)

5366 (RFP-Trans—169) Note on the reaction of BIS(trimethylsilyl)-diimine with carbon dioxide. Wiberg, N.; Schwenk, G. Translated from *Chem. Ber.*; **104**: 3986-3988(1971). 3p. Dep. NTIS $4.50.

Instead of the predicted azocarboxylic acid esters, the reaction of bis(trimethylsilyl)diimine and CO_2 produced hydrazine and

tetrazole compounds, free nitrogen, and hexamethyldisiloxane. It is assumed that the formation of the hydrazine and tetrazole compounds proceeds through one of the predicted azo compounds. Results of NMR studies are given. (JGB)

5367 (UCRL-Trans—1521) **Epimination of olefins by 3,3-pentamethylene oxaziridine single-stage synthesis of aziridines.** Schmitz, E.; Joehnisch, K. Translated by E.A. Selge from *Khim. Geterotsikl. Soedin., Akad. Nauk Latv. SSR;* No. 12, 1629-1638(1974). 17p. Dep. NTIS $4.00.

5368 **Pressure and temperature dependence of the dielectric and ultrasonic properties of polychlorotrifluoroethylene (PCTFE).** Samara, G.A.; Fritz, I.J. (Sandia Labs., Albuquerque, NM). *J. Polym. Sci., Polym. Lett. Ed.;* 13: No. 2, 93-99(Feb 1975).

5369 **Precision neutron diffraction structure determination of protein and nucleic acid components. XVII. Molecular and crystal structure of the amino acid glycine hydrochloride.** Al-Karaghouli, A.R.; Cole, F.E.; Lehman, M.; Miskell, C.F.; Verbist, J.J.; Koetzle, T.F. (Brookhaven National Lab., Upton, NY). *J. Chem. Phys.;* 63: No. 4, 1360-1366(15 Aug 1975).

The amino acid salt glycine hydrochloride, crystallizes in the space group $P2_1/c$, a = 7.117(2) A, b = 5.234(2) A, c = 13.745(3) A, β = 97.25(1)°. The crystal structure has been refined from three-dimensional neutron diffraction data to a final R value based on F^2 of 0.058. Estimated standard deviations in bond distances and angles are approximately 0.002 A and 0.2°, respectively. There is a network of hydrogen bonds with the chloride ions linking three neighboring glycines to form layers parallel to the ab plane. One ammonium group hydrogen is involved in two weak electrostatic interactions; these interactions join the single layers to form parallel double layers but are probably too weak to be termed hydrogen bonds. (auth)

5370 **Limit cycle oscillations in the reversible Oregonator.** Field, R.J. (Carnegie—Mellon Univ., Pittsburgh). *J. Chem. Phys.;* 63: No. 6, 2289-2296(15 Sep 1975).

The five-step Oregonator model of the oscillatory Belousov—Zhabotinskii reaction has been expanded by taking into account the reversibility of the various steps. Forward and reverse rate constants have been assigned to four of the five steps by direct analogy to the detailed Field, Koros, and Noyes model of the Belousov-Zhabotinskii reaction. The rate constants and stoichiometry of the fifth step were parametrized and the stability of the steady state was investigated as a function of both of these parameters and the overall distance of the system from equilibrium. It was found that there is a critical distance from equilibrium which must be exceeded before the steady state becomes unstable. Numerical integration of the differential equations resulting from the model indicated that the system executes apparent limit cycle oscillations when the steady state is unstable. Introduction of reversibility into the Oregonator leads to a striking change in the range of values of the fifth step stoichiometric parameter over which oscillations will occur. This change is discussed in terms of the chemistry of the Belousov-Zhabotinskii reaction. Under some conditions the reversible Oregonator shows excitability such that a small finite perturbation of an infinitesimally stable steady state may be greatly amplified before the system returns to rest. An apparently analogous phenomenon appears in the Belousov-Zhabotinskii reaction itself. (auth)

5371 **Optically detected magnetic resonance spectra of the lowest triplet state of 1-iodonaphthalene in durene at zero and high magnetic fields.** Kothandaraman, G. (Univ. of Pittsburgh); Pratt, D.W.; Tinti, D.S. *J. Chem. Phys.;* 63: No. 8, 3337-3348(15 Oct 1975).

This paper describes the results of optically detected magnetic resonance (ODMR) experiments on photoexcited 1-iodonaphthalene (1IN) in a durene host crystal at liquid helium temperatures. The structure observed in both the zero-field (zf) and high-field ODMR transitions is interpreted in terms of a spin Hamiltonian which includes the complete iodine (I = $^5/_2$) nuclear quadrupole and hyperfine interactions. Principal values of D (including the absolute signs), P, A′, and estimates of the direction cosine matrices and the components of g are reported. It is concluded from this analysis that (1) the lowest triplet state of 1IN is principally (π,π^*) in character but (2) is contaminated by slight admixtures of charge-transfer configurations; (3) the zf parameters of triplet 1IN are considerably perturbed from those of ^{3}B/sub 2u/ naphthalene and presumably reflect the increased importance of second-order spin—orbit contributions to D in the presence of the heavy-atom substituent; and (4) 1IN occupies two magnetically inequivalent sites in the durene lattice which are not substitutional. (auth)

5372 **High pressure studies on spiropyrans.** Wilson, D.G.; Drickamer, H.G. (Univ. of Illinois, Urbana). *J. Chem. Phys.;* 63: No. 8, 3649-3655(15 Oct 1975).

High pressure optical measurements have been made on two spiropyrans dissolved in films of polystyrene (PS) and polymethyl methacrylate (PMMA). Three types of studies were made. (1) In the pressure region 30-140 kbars we observed pressure induced coloration (piezochromism) which was independent of time, rate of pressure application, or irradiation. The evidence favors a direct thermal transition between the uncolored and colored ground states. The volume change involved in the transition is of the order of 0.5-1.5 cm^3/mol. (2) In the pressure range 8-40 kbars, it was demonstrated that pressure drastically reduced the efficiency of the photochromic process. This process proceeds via a triplet state of the uncolored molecule. With increasing pressure the energy of a triplet state increases with respect to the excited singlet state, which reduces the probability of intersystem crossing and therefore of formation of the colored species. (3) In the pressure range 0-10 kbars the rates of thermal bleaching were studied and discussed in terms of a current theory of the processes involved. Some measurements of rates of photocoloration and photobleaching are also described. (auth)

5373 **Spin species conversion and the heat capacity of solid methane near 1°K.** Vogt, G.J.; Pitzer, K.S. (Univ. of California, Berkeley). *J. Chem. Phys.;* 63: No. 8, 3667-3668(15 Oct 1975).

The heat capacity of samples of methane containing controlled amounts of a spin-species conversion catalyst (oxygen) was measured to study the energy levels and interconversion properties of the various nuclear-spin species of methane. (LK)

5374 **Acetyl cation and its geometrical isomers.** Yarkony, D.R.; Schaefer, H.F. III. (Univ. of California, Berkeley). *J. Chem. Phys.;* 63: No. 10, 4317-4328(15 Nov 1975).

Ab initio self-consistent-field (SCF) calculations are reported on the acetyl cation (CH_3CO^+) and three of its possible geometrical isomers. The wavefunctions are discussed in terms of Mulliken populations and simple valence bond arguments. The energies of the low-lying electronic states of CH_3CO^+ are estimated and compared with those of CO. The similarities and differences are explained in terms of simple chemical arguments. Finally an accurate two configuration wavefunction for the CH_3CO^+ fragmentation is presented, showing unambiguously the dissociation products to be the expected ones, CH_3^+ and CO. (auth)

ISOTOPE EFFECTS

5375 **Diffraction pattern and structure of aqueous hydrochloric acid solutions at 20 degreeC.** Triolo, R.; Narten, A.H. (Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* 63: No. 8, 3624-3631(15 Oct 1975).

Hydrochloric acid solutions have been studied at concentrations from pure water to saturation with both x rays (HCl/H_2O) and thermal neutrons (DCl/D_2O). Such an extensive study reduces greatly the nonuniqueness of interpretation usually associated with diffraction data from liquids. The structure of D_2O molecules in liquid water is very similar to that found in the vapor phase, the OD distance of 0.955(5) A being identical to the equilibrium distance in the vapor molecules. The existence of D_3O^+ ions with an OD distance of 1.017(5) A in concentrated DCl is firmly established. The $D_3O^+(H_3O^+)$ ions are hydrogen bonded to four water molecules with an H_3O^+center-dotcenter-dotcenter-dotOH$_2$ distance of 2.52(2) A and a D_3O^+center-dotcenter-dotcenter-dotD distance of 1.61(2) A. The Cl^- ions appear to be four-coordinated by oxygen atoms at a mean distance of 3.13(1) A, but no pronounced Clcenter-dotcenter-dotcenter-dotD distances indicating a well-oriented hydration shell about Cl^- could be identified.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

5376 (SRO—854-4) **Gas-chromatographic fractionations of stable isotopes of carbon and oxygen in carbon dioxide.** Shepard, A.T.; Danielson, N.D.; Pauls, R.E.; Mahle, N.H.; Taylor, P.J.; Rogers, L.B. (Georgia Univ., Athens (USA). Dept. of Chemistry). 1975. 20p. Dep. NTIS $4.50.

A high-precision gas chromatograph was used in conjunction with a quadrupole mass spectrometer and an on-line computer to study the fractionation of carbon and oxygen isotopes in carbon dioxide on two solid adsorbents and on a variety of liquid phases. For adsorption studies, the relative retention is reported as a function of temperature on Porapak Q and silica gel. On the former, α values are on the order of 1.0027 +- 0.0001 (standard deviation) for the carbon isotopes and 1.0011 +- 0.0002 for the oxygen species, while on silica gel, the values are 1.0031 +- 0.0004 and

1.0050 +- 0.0008, respectively. Differential thermodynamic data are reported. Using diethanolamine and polyethylene imine columns in gas—liquid chromatography, greater fractionation was found. However, column bleed and decomposition of the liquid phase were serious problems. (auth)

5377 Sequential deuterium exchange reactions of protonated benzenes with D_2O in the gas phase by ion cyclotron resonance spectroscopy. Freiser, B.S.; Woodin, R.L.; Beauchamp, J.L. (California, Inst. of Tech., Pasadena). *J. Am. Chem. Soc.*; 97: No. 23, 6893-6894(12 Nov 1975).

Results are reported results on a novel deuterium exchange reaction, observed using ion cyclotron resonance (ICR) spectroscopy. In apparent contrast to previously reported results sequential reactions of protonated aromatic compounds with D_2O in the gas phase occur which lead to various degrees of ring deuteration. For example, reactions in a mixture of benzene and D_2O produce $C_6H_6D^+$, which in further reaction with D_2O undergoes rapid stepwise exchange of H for D. From the data summarized for the halo and alkyl substituted benzenes it is apparent that deuterium exchange varies significantly for different structural isomers. Thus while o- and p-difluorobenzene exchange all hydrogens rapidly, the meta isomer slowly exchanges only a single hydrogen. Species such as the benzoyl cation, radical cations, and $C_7H_7^+$ derived from toluene and cycloheptatriene do not undergo exchange. It appears that ring protonation is a necessary condition for exchange to occur. (JGB)

ELECTROCHEMISTRY

5378 (LBL—3913) **Mass transfer in rotating electrode systems.** Mohr, C.M. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1975. Contract W-7405-ENG-48. 138p. Dep. NTIS $7.00.

Thesis.

Four studies of rotating electrode systems are reported. An improved method of solution for the hydrodynamics of a rotating disk employing a series-matching technique is presented. The results represent the most accurate evaluation of certain flow-field parameters derived to date. Mass-transfer rates are calculated as a function of the amount of offset center of rotation employing a numerical technique, and an analytic asymptotic model for large offsets is developed. These predictions are tested by deposition experiments with a series of electrodes of varying eccentricities. An experimental study of the diffusion-limited rate of mass transfer to a rotating disk electrode in the transition region between the laminar and turbulent flow regimes is reported. An experimental study of the mass transfer in turbulent flow between concentric cylinders, the inner of which is rotated, is presented. A numerical model based upon the concept of a universal eddy diffusivity profile for turbulent flows is derived and is shown to be inappropriate for this turbulent flow. (auth)

RADIATION CHEMISTRY

5379 (COO—3435-21) **Electron paramagnetic resonance study of conformational effects in alkyl-substituted 2-cyclohexanonyl radicals in an adamantane matrix.** Walter, H.F. (Pittsburgh Univ., Pa. (USA)). 1975. 124p. Dep. NTIS $6.50.

Thesis.

Electron paramagnetic resonance spectra have been obtained for radicals produced by x-irradiation of cyclohexanone and various alkyl-substituted cyclohexanones trapped in an adamantane matrix. Temperature variation of these spectra permits determination of the enthalpy and entropy of activation for interconversion between the two half-chair conformations. In those cases where the two conformations have intrinsically different energies, the enthalpy and entropy differences between conformations are determined. For 2-cyclohexanonyl radical, the enthalpy of activation is 3.90 +- 0.07 kcal/mole and the entropy of activation is -2.3 +- 0.3 e.u. Methyl substitution on C_3 or C_5 gives a radical with activation parameters similar to the parent radical, indicating moderate realignment of atoms during the conformational change. Methyl substitution on C_4 gives a radical with lower activation parameters, which are interpreted to indicate conformational change mainly be a folding along the diagonal through the radical site. Larger groups attached to C_5 influence enthalpy and entropy differences between conformations much less than when they are attached to C_4. Very large groups attached to C_5 apparently flatten the ring; it is not known whether or not this is a matrix effect. Deuteration seems to cause a slight reduction in the activation parameters for 2-cyclohexanonyl radical. (auth)

5380 (COO—3435-24) **Conformational analysis of the EPR spectra of cyclohexenyl radical and some of its alkyl derivatives.** de Tannoux, N.M. (Pittsburgh Univ., Pa. (USA)). 1975. 55p. Dep. NTIS $5.50.

Thesis.

Electron paramagnetic resonance spectra have been obtained for radicals produced by x-irradiation of cyclohexene and various alkyl-substituted cyclohexenes trapped in an adamantane matrix. Temperature variations of these spectra permits determination of the enthalpy and entropy of activation for interconversion between the conformations. For cyclohexenyl radical, the enthalpy of activation is 6.81 +- 0.58 kcal/mole and the entropy of activation is -0.04 +- 2.38 e.u. Methyl substitution on C_1 gives a radical with activation parameters similar to the parent radical. Methyl groups attached to C_5 increase the activation parameters significantly. On the basis of these observations, it is suggested the cyclohexenyl radicals exist in two conformations of the same energy which are of the "envelope" type, with C_1, C_2, C_3, C_4, and C_6 coplanar. A model involving a planar transition state for the interconversion process is proposed which accounts for most of the experimental results. (auth)

5381 (ORO—3781-12) **Investigation of gamma-ray induced polymer formation of the carboranes. Progress report, November 1, 1974—October 31, 1975.** Klingen, T.J. (Mississippi Univ., University (USA). Dept. of Chemistry). 31 Oct 1975. Contract AT(40-1)-3781. 24p. Dep. NTIS $4.50.

Progress is reported in studies on radioinduced polymerization in organo substituted derivatives of 1,2-dicarba-closo-dodecarborane-(11),o-carborane. They include studies on: INDO calculations of charge transfer; dipole moments and plastic crystallinity; o-carborane radiolysis; and, the radiolysis of 1-phenyl-o-carborane. (JGB)

5382 (AEC-tr—7533/4) **Nukleonika.** Translation of *Nukleonika;* 19: No. 4, 275-386(1974). 99p. (TT—74-54003/4). Dep. NTIS $6.00.

5383 Photostimulated reactions of isolated and paired radicals in solid hydrocarbons. Sprague, E.D.; Willard, J.E. (Department of Chemistry, University of Wisconsin, Madison, Wisconsin 53706). *J. Chem. Phys.*; 63: No. 6, 2603-2608(15 Sep 1975).

Ultraviolet radiation absorbed by radicals trapped in γ-irradiated 3-methylpentane (3MP), 3-ethylpentane (3EP), and 3-methylheptane (3MHp) glasses and in polycrystalline n-hexane at 77°K causes a major improvement in resolution of the ESR spectra without change in the radical concentration, indicating that the energy of the absorbed photons changes the nature, the configuration, or the environment of the radicals. The new spectral shape slowly reverts to the old in the dark at a rate which is dependent on the matrix and the temperature. Ultraviolet irradiation also accelerates the decay of paired radicals and other radicals which are removed by intraspur processes, but not of those which react by random encounter after diffusion. This effect is attributed to localized heating of the matrix in the immediate vicinity of a radical which has absorbed a photon. Secondary 3-ethylpentyl radicals in glassy 3EP undergo spontaneous conversion to an isomer or change to a new rotamer configuration in the dark and the process is reversed by exposure to uv light. The ΔM/subs/=2 ESR spectrum of radical pairs in γ-irradiated 3MHp has been observed.

5384 Separation of isotropic and anisotropic hyperfine constants in disordered systems by analysis of electron paramagnetic resonance lines at two different microwave frequencies: Application to the molecular structure around excess electrons in γ-irradiated 10M sodium hydroxide alkaline ice glass. Bales, B.L.; Bowman, M.K.; Kevan, L.; Schwartz, R.N. (Centro de Fisica, I.V.I.C., Caracas, Venezuela). *J. Chem. Phys.*; 63: No. 7, 3008-3014(1 Oct 1975).

It is shown that the second moment of an unresolved electron paramagnetic resonance line in disordered systems can lead to separation of the isotropic and anisotropic hyperfine couplings if the spectrum is recorded at high enough microwave frequency to separate the main line from nuclear spin flip satellite lines. If resolution of main and satellite lines is not complete, separate determination of the isotropic and anisotropic couplings is still possible if measurement can be made at two different microwave frequencies of which one frequency is high enough to partially resolve the main and satellite lines. This analysis is applied to excess electrons trapped in 10M NaOH alkaline ice glass at 77 K and the isotropic and anisotropic coupling constants are determined as a function of n, the number of equivalent nearest neighbor protons. From electron spin echo modulation patterns and the intensity and separation of satellite lines from the main line, the best value of n is determined to be 6. The value n=6 corresponds to a trapped electron surrounded by three water molecules with their

molecular dipoles oriented toward the electron (2 protons per water molecule) or six water molecules with one OH bond oriented toward the electron. In both cases the protons are 2.1 A from the electron with an isotropic coupling constant of ~1—2 G. This agrees with independent measurements from analysis of electron spin echo modulation patterns.

5385 Electron spin echo envelope modulation of trapped radicals in disordered glassy systems: Application to the molecular structure around excess electrons in γ-irradiated 10M sodium hydroxide alkaline ice glass. Narayana, P.A.; Bowman, M.K.; Kevan, L.; Yudanov, V.F.; Tsvetkov, Y.D. (Department of Chemistry, Wayne State University, Detroit, Michigan 48202). *J. Chem. Phys.*; 63: No. 8, 3365-3371(15 Oct 1975).

Electron spin echo signals associated with trapped electrons in aqueous matrices show a modulation due to hyperfine interaction with the surrounding magnetic nuclei. The three pulse electron spin echo modulation gives information about the next nearest neighbor deuterons surrounding the electron. Analysis of the phase change in the three pulse modulation gives an effective deuteron interaction distance of 3.6 A. The two pulse spin echo modulation depends on both the nearest and next nearest neighbor deuterons. Simulations of this modulation support a structural model in which the number of equivalent nearest neighbor deuterons to the electron is 6 at a distance of 2.1 A and with an isotropic coupling constant of 0.9 MHz (5.8 MHz for protons). The orientation of the water molecules in the first solvation shell is not uniquely determined and two possible models are proposed. In model I there are three first solvation shell water molecules with their molecular dipoles oriented toward the electron so that there are two nearest neighbor deuterons from each molecule. In model II there are six first solvation shell water molecules with one OD bond oriented toward the electron. Model I is approximately consistent with the semicontinuum model for solvated electrons although the experimental distances are 0.2—0.3 A larger than the predicted point dipole distances.

5386 Ion mobility measurements in dielectric liquids. Winokur, P.S.; Roush, M.L.; Silverman, J. (Harry Diamond Laboratories, Adelphi, Maryland 20783). *J. Chem. Phys.*; 63: No. 8, 3478-3489(15 Oct 1975).

Mobilities have been determined by fitting theoretical current—time curves to experimental ones. The theoretical current—time curves were obtained by solving numerically the differential equations governing carrier motion during a mobility measurement.The current—time curves generated from the model are in good agreement with those obtained experimentally. The theoretical model that includes the effects of induced bulk liquid motion yields values of mobility that are significantly lower than those determined experimentally by use of inflection or "half-steady-state" points. Measurements made on purified n-hexane showed that a radiation pulse produces more than one slow carrier of each sign. When biphenyl was added to the sample, one negative and two positive species were observed. Our theoretical fits to experimental curves obtained from the irradiation of a 0.22M solution of biphenyl in n-hexane yields a mobility value for the negative species of 3.6times10^{-4} cm^2 V^{-1}center-dotsec^{-1}. This negative species is believed to be the biphenylide anion.

5387 Indirect excitation of $Cl^-(^3P)$ in pulse-irradiated aqueous solutions. Energy transfer to TlCl/sub n//sup 1-n/ and electron transfer to Eu^{3+}. Huang, T.; Hamill, W.H. (Univ. of Notre Dame, IN). *J. Phys. Chem.*; 79: No. 23, 2465-2469(6 Nov 1975).

In concentrated solutions of NaCl and greater than or equal to 0.05 M $EuCl_3$ a prompt yield of Cl_2^- istributed to H_2O^+ and a slow yield of CL_2^- is attributed to electron transfer from Cl^{-*} to Eu^{3+}. The concentration dependence $\Delta G(Cl_2^-)$ vs. $[Cl^-]$ from 0.25 to 1.7 M is consistent with primary energy deposition in water and transfer from a short-lived species to Cl^-. The lifetime of Cl^{-*} is greater than 10^{-6} sec and it is described as $Cl^-(^3P$/sub J/). The slow yield of Cl_2^- decreases markedly above 2 M NaCl. With approximately 10^{-4} M Tl^+ and concentrated KCl a luminescence under pulsed electron irradiation is the same as that under uv excitation of TlCl/sub n//sup 1-n/. The intensity increases with chloride ion concentration to approximately 2 M, then decreases markedly. The dependence is very similar for concentrated HCl and combination of CL_2^- with e^-/sub aq/ cannot be responsible for excitation. The primary excited species appears to be produced by fast recombination of the dry charge pair, H_2O^+ and e^-. Electron transfer from Cl^- to H_2O^+ at high concentrations of Cl^- suppresses the yield of primary excited species, presumably triplet, and possibly H_2O or H_2O^+. (auth)

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

HOT-ATOM CHEMISTRY

5388 (COO—2190-16) **Dynamics and mechanisms of hot chemistry stimulated by recoil methods. Progress report, March 1, 1975—February 29, 1976.** Spicer, L.D. (Utah Univ., Salt Lake City (USA)). Nov 1975. Contract E(11-1)-2190. 18p. Dep. NTIS $4.50.

A technique for the quantitative investigation of vibrational energy transfer efficiencies at very high levels of excitation is described. In this method chemical activation by nuclear recoil reaction is utilized and the competitive stabilization-decomposition characteristics of the resulting unimolecular system are probed as a function both of pressure and bath gas composition. The relative energy transfer efficiencies for collisions between excited cyclobutane-t and He, Ne, Ar, Kr, Xe, N_2, CF_4, c-C_4H_8 are reported. The hot atom reaction between nuclear recoil chlorine atoms and hydrogen gas to produce translationally excited hydrogen chloride is reported. A sizable hydrogen isotope effect was observed in this system between H_2 and D_2 reactant and there appears to be a cross over from normal to inverse isotope effect as the relative laboratory collision energy is increased above the thermal threshold region. Evidence for electronically excited $S(^1D)$ reactions of nuclear recoil produced sulfur atoms is reported on the basis of relative product yields as a function of electronic energy quenching additives. (auth)

5389 (ORO—3898-27) **Hot atom reactions involving multivalent and univalent species. Progress report, February 1975—January 1976.** Tang, Y.N. (Texas Agricultural and Mechanical Univ., College Station (USA). Research Foundation). 1975. Contract AT(40-1)-3898. 14p. Dep. NTIS $4.50.

Progress has been made during this period in the study of three kinds of multivalent hot atoms formed by the nuclear recoil method: ^{31}Si, ^{32}P, and ^{11}C. For ^{31}Si recoil reactions, effects of additives on the reactions of monomeric $^{31}SiF_2$ with 1,3-butadiene were studied. It was concluded that recoil ^{31}Si reactions with PF_3 resulted in the formation of both singlet and triplet $^{31}SiF_2$ in the ratio of 1.0:3.3. For recoil ^{32}P reactions, a moderator study was made on the effect of He, Ne, and Ar on the ^{32}P abstraction reactions. The reaction probability curve for the H-abstraction from PH_3 to give $^{32}PH_2$ covers an extremely wide range but has a threshold somewhat above the thermal energy range, while the reaction probability curve for the F-abstraction from PF_3 to give $^{32}PF_2$ is narrow but has a threshold in or below the thermal energy range. Mechanistic studies were made for ^{32}P abstraction reactions with a PF_3/PCl_3 mixture. Both a single-step simultaneous abstraction and a stepwise abstraction mechanism must be present. The effect of pressure and scavenger concentration on various products observed in the recoil ^{11}C reactions with 1,3-butadiene has been extensively studied. It is also observed that with the addition of an easily abstractable hydrogen source such as SiH_4 to the system, the acetylene-^{11}C yield decreases sharply while products corresponding to $^{11}CH_2$ reactions increase. (auth)

5390 Ethylene formation in carbon atom reactions. Mechanism and isotope effects. Taylor, K.K.; Ache, H.J.; Wolf, A.P. (Virginia Polytechnic Inst. and State Univ., Blacksburg, VA). *J. Am. Chem. Soc.*; 97: No. 21, 5970-5974(15 Oct 1975).

Energetic carbon-11 atoms were allowed to react with specifically deuterated hydrocarbons containing completely deuterated methyl or methyne groups and with mixtures of protonated and perdeuterated hydrocarbons. The doubly labeled ethylenes (^{11}C and D) formed in this process were radio gas chromatographically analyzed. The failure to observe carbon-11 labeled $C_2H_2D_2$ in any of these systems suggests that a mechanism including C_2 formation, e.g., by "high-energy stripping", and subsequent hydrogen abstraction does not significantly contribute to ethylene-^{11}C production. The ratios $^{11}C_2H_3D/^{11}C_2H_4$ and $^{11}C_2D_4/^{11}C_2HD_3$ obtained from reaction in equimolar mixtures of C_2H_4 and C_2D_4 or C_2H_2 and C_2D_2 and in CH_2CD_2 are consistently greater than 1, which provides additional support for the contention that ethylene-^{11}C is formed primarily via mythyne insertion into the carbon-hydrogen bonds of methyl groups. The ^{11}C distribution among the various isotopic ethylenes observed in the systems under investigation indicates preferential CD formation and preferred insertion by methyne (^{11}CD or ^{11}CH) into CH_2 relative to CD_2 groups. (auth)

PROPERTIES OF RADIOACTIVE MATERIALS

5391 (ANCR—1257) **Removal of the Materials Test Reactor overhead working reservoir.** Lunis, B.C. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Oct 1975. Contract E(10-1)-1375. 24p. Dep. NTIS $4.00.

Salient features of the removal of an excessed contaminated facility, the Materials Test Reactor (MTR) overhead working reservoir (OWR) from the Test Reactor Area to the Radioactive Waste Management Complex at the Idaho National Engineering Laboratory are described. The 125-ton OWR was an overhead 160,000-gallon-capacity tank approximately 193 feet high which supplied cooling water to the MTR. Radiation at ground level beneath the tank was 5 mR/hr and approximately 600 mR/hr at the exterior surface of the tank. Sources ranging from 3 R/hr to in excess of 500 R/hr exist within the tank. The tank interior is contaminated with uranium, plutonium, and miscellaneous fission products. The OWR was lowered to ground level with the use of explosive cutters. Dismantling, decontamination, and disposal were performed by Aerojet Nuclear Company maintenance forces. (auth)

5392 (ANL—75-47) **Chemical Engineering Division thermochemical studies. Annual report, July 1974—June 1975.** O'Hare, P.A.G.; Johnson, G.K.; Ader, M.; Hubbard, W.N.; Fredrickson, D.R.; Cafasso, F.A.; Burris, L. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 56p. Dep. NTIS $5.45.

Standard enthalpies of formation were determined for the following compounds: $Cs_2U_2O_7$(c), β-Na_2UO_4(c), $BaUO_4$(c), HI(aq), $CsNO_3$(c), Cs_2CO_3(c), CsCl(c), RbCl(c), Cs_2CrO_4(c), and Cs_2Cr_2O(c).Preliminary reaction calorimetric studies of WS and Li—Al alloys are described. High-temperature enthalpies and other thermodynamic properties are reported for α- and β-Na_2UO_4(c), Cs_2UO_4(c), and Al_2O_3(c). (auth)

5393 (ANL—75-50) **Chemical Engineering Division. Liquid metals chemistry and tritium control technology annual report, July 1974—June 1975.** Maroni, V.A.; McPheeters, C.C.; Calaway, W.F. (Argonne National Lab., Ill. (USA)). Sep 1975. Contract W-31-109-Eng-38. 44p. Dep. NTIS $4.00.

A program is in progress to develop the capabilities for monitoring hydrogen and tritium in LMFBR sodium and cover gas and to develop means of control of tritium in sodium. Both the in-sodium and cover-gas tritium monitors are similar in design to the hydrogen monitors. The in-sodium tritium monitors were tested for response to changes in tritium level in sodium. A cover-gas tritium monitor was designed for testing and further development. Final results of tensimetric studies of the Li—LiD system are reported. Comparison of the Li—LiD data with previous results for the Li—LiH system shows that the isotope effects in these systems originate largely from the gas phase. The solubility of hydrogen in β-phase Li—Al alloy was found to be significantly lower than that in pure lithium at comparable temperatures and equilibrium hydrogen pressures. Decomposition pressure data, together with previously measured solubilities of Li_3N in liquid lithium, were used to determine (1) the equilibrium constant for the formation of Li_3N/sub (s)/ from liquid lithium and gaseous nitrogen, (2) the free energy of formation of solid Li_3N, and (3) the Sieverts' law constant for dilute solutions of Li_3N in liquid lithium. Hydrogen permeation characteristics of multiplex metal laminates indicate that these materials may be of potential utility as barriers to tritium migration. Studies of the kinetics of chemical trapping reactions involving tritium in inert gas streams are reported. Progress in the assessment of tritium handling and containment requirements for a tokamak experimental fusion power reactor (TEPR) is reported. (JGB)

5394 (CONF-750410—10) **Preparation of ^{82}Br or ^{80}Br-biomolecules via excitation labelling methods.** Wong, S.; Ache, H.J. (Virginia Polytechnic Inst., Blacksburg (USA). Dept. of Chemistry). 1975. 22p. Dep. NTIS $4.50.

From 169. national meeting, American Chemical Society; Philadelphia, Pennsylvania, USA (6 Apr 1975).

The direct decay-induced ^{82}Br (or ^{80}Br) labelling by exposing the solid substrate molecules, such as deoxyuridine, L-tyrosine, guanosine, deoxycytidine, phenylalanine, and acetic acid, to gaseous $CF_2{}^{82}$/sup m/Br (or $CF_2{}^{80}$/sup m/Br) was studied. The radiochemical yields of the brominated products are relatively small and range from 1 percent in the case of bromo deoxyuridine to 11 percent for bromoacetic acid. The modification of this technique by adding Cl_2 gas to the reaction mixture improves the yields in several cases drastically (up to 80 percent for bromoguanosine and bromo-L-tyrosine). Similar improvement can be achieved by exposing crystalline $KBrO_3$ for some time to $CF_2{}^{82}$/sup m/Br (or $CF_2{}^{80}$/sup m/Br) and dissolving subsequently the $KBrO_3$ in an acidic solution of the substrate. (auth)

5395 (CONF-750915—22) **Electronic structure of uranyl compounds: an XPS study.** Veal, B.W.; Lam, D.J.; Hoekstra, H.R.; Carnall, W.T. (Argonne National Lab., Ill. (USA)). 1975. 9p. Dep. NTIS $4.00.

From 5. international conference on plutonium and other actinides; Baden-Baden, F.R. Germany (10 Sep 1975).

X-ray photoemission spectroscopy (XPS) measurements are reported for a series of uranyl compounds in which the primary uranium—oxygen (U—O/sub I/) separation varies substantially. Crystal field splittings of the U $6p_{3/2}$ core electron energy levels were observed. These splittings are explained with the point charge crystal field model when both first and second near uranium neighbors are considered. The systematics of charge migration (observed by monitoring electron core level shifts) associated with bonding in the uranyl series were also investigated. Core level shifts for compounds with different U—O/sub I/ separations are large, but essentially no relative shifts of uranium and oxygen core levels were observed within the uranyl group. Thus charge appears to flow between the uranyl group (as a unit), and the secondary uranium ligands as U—O/sub I/ is varied. The U 5f electron participation in covalent bonding was also studied by systematically measuring XPS line intensities; U 5f electron occupation appears to be minimal. (auth)

5396 (ORNL—5050, pp 72-78) **Studies in chemical engineering science.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

Measurements of mass transfer rates in open bubble columns; studies of oxidation of tritium as it permeates fusion reactor containment, flooding studies in columns filled with Goodloe packing, studies of mass transfer rates between water and mercury, preparation of small particles, and development of equipment are reported. (MCG)

5397 (UNI-SA—18) **Decontamination and decontaminant waste disposal.** Kratzer, W.K. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 9 Oct 1975. 20p. Dep. NTIS $4.50.

Typical decontaminations expected at nuclear power reactors and the problems associated with the processing of decontamination wastes are described. (LK)

5398 (ORNL-tr—4039(Draft)) **Chemical separation of nielsbohrium as ekatantalum in the form of anhydrous bromide. II. Experiments with spontaneously fissioning nielsbohrium isotopes.** Zvara, I.; Belov, V.Z.; Domanov, V.P.; Shalaevskii, M.R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1975. Translated by M. Gerrard from JINR—P6-8740. 11p. Dep. NTIS $4.50.

The behavior of nielsbohrium and niobium—bromine compounds was compared using the frontal thermochromatography technique. The nielsbohrium spontaneous fission isotope was produced by bombarding an americium-243 target with neon-22 ions. The niobium-90 isotope was produced simultaneously in nuclear reaction with bromine. The adsorption zone of nielsbohrium is formed at a slightly higher temperature as compared with niobium and tantalum. Similar results were obtained in previous investigations of the properties of chlorine compounds of element 105. This agrees with the expected properties of nielsbohrium as ekatantalum. (auth)

5399 **Electronic energy level and intensity correlations in the spectra of the trivalent actinide aquo ions. II. Cm^{3+}.** Carnall, W.T.; Rajnak, K. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* 63: No. 8, 3510-3514(15 Oct 1975).

The free-ion energy level scheme of Cm^{3+} (aquo) to ~40 000 cm^{-1} was determined. Energy level assignments were made based on the correlation between observed band intensities and those calculated using the Judd—Ofelt theory. Use of an expanded set of effective operators provided the basis for computation of free-ion energies in good agreement with the experimental assignments.

RADIOISOTOPE PRODUCTION

5400 (BNL—20326) **Production and quality control of iodine-123.** Lambrecht, R.M.; Kondo, K.; Wolf, A.P. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 30p. (CONF-750564—2). Dep. NTIS $4.50.

From Iodine-123 planning conference; Rockville, Maryland, USA (19 May 1975).

The various methods for production and quality control are discussed. The author feels the ^{123}Xe-^{123}I generator is the best method of production. Preparation and use of ^{123}I-labeled compounds are also considered. (LK)

5401 (ORNL—5050, pp 20-23) **Transuranium-element processing.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

Two target processing campaigns were conducted, and 23 HFIR targets were processed. Key isotopes in the campaign

products are ^{243}Am, ^{244}Cm, ^{249}Bk, ^{252}Cf, ^{253}Es, and ^{257}Fm. Five sources containing from 0.9 μg to 13 mg ^{252}Cf were fabricated. (LK)

ENGINEERING

GENERAL ENGINEERING

5402 (HEDL-SA—754) **Corrective action (a talk to American Society for Quality Control).** Garland, D.L. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jun 1973. Contract E(45-1)-2170. 6p. (CONF-751040—1). Dep. NTIS $4.50.

From A talk to American Society for quality control; Richland, Washington, USA (23 Oct 1975).

The elements of an effective Corrective Action program for achieving quality assurance include appraisal of the cause of the error and identification of action to correct that cause; evaluation of completed products; evaluation of related products and processes; and follow-up for effectiveness of corrective action. These elements and examples of their application are discussed. (LCL)

5403 (MHSMP—75-38) **Results of a study to investigate the reliability of preventive maintenance standard times.** Walsh, J.M. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 15 Sep 1975. Contract DA-11-173-AMC-487. 66p. Dep. NTIS $5.50.

In January of 1975, a report entitled "The Design of a Study to Investigate the Reliability of Preventive Maintenance Standard Times" was submitted to Plant Engineering's division management for review and approval. The report outlined (1) the proposed approach to establish reliable PM standard times, (2) the investment required to employ the specified techniques, and (3) the expected benefits to be gained from the project. The proposed study has been approved, implemented, and completed. Results of the effort and recommendations to management regarding follow-up activities are offered. (TFD)

FACILITIES AND EQUIPMENT

5404 (ANL-Trans—1026) **Analysis of the vibrations and instabilities in the operation of turbine-pumps.** Casacci, S.; Wegner, M.; Gulton, P. Translated from *Houille Blanche;* **26**: No. 6, 519-529(1971). 24p. Dep. NTIS $3.50.

The nature of the vibrational phenomena in turbine-pumps is analyzed for the following operating regimes: pump operation at low and at high flow rates; operation in the pump-brake regime; and turbine operation from low flow to runaway operation. The various types of vibrations that the different operating regimes can induce in specific parts of the turbomachinery are defined and tabulated. Previous research on turbine-pump vibrations and instability is reviewed, and possible approaches for future studies are discussed. (LCL)

5405 (CONF-750977—, pp 2.1-2.12) **Application of the fundamental conservation equations to steam generator dynamic modeling.** Yahalom, R. 1975.

From 2. power plant dynamics, control and testing symposium; Knoxville, Tennessee, USA (3 Sep 1975).

In Proceedings of the second power plant dynamics, control and testing symposium.

The investigator attempting to model a steam generator in which two phase steam flow occurs faces a dilemma. On one hand he would like the model to be as accurate as possible, and, on the other, he would prefer to avoid computational complexities, numerical difficulties and very high computer costs. In searching for a compromise it is necessary to resort to a series of simplifications and assumptions concerning the governing equations. In many instances simplified equations developed by other investigators might be inadvertently applied to cases which violate the simplifying assumptions. This work clarifies some of the simplifications that are made, especially those concerning the non-stationary terms, and establishes the criteria by which the suitability of various dynamic models can be determined. (auth)

5406 (N—75-17188, pp 153-163) **Initiatives of the Los Alamos Scientific Laboratory in the transfer of a new excavation technology.** Hanold, R.J.; Bankston, C.A.; Rowley, J.C.; Long, W.W. (Los Alamos Scientific Lab., NM). 1974.

From Technology transfer conference; Houston, Texas, USA (24 Sep 1974).

In Proceedings of the first 1974 technology transfer conference.

The Subterrene is a system invented and patented by LASL for making vertical or horizontal holes in rocks and soils by progressive local melting. The use of the melting penetrator permanently makes self-supporting holes in unconsolidated sediments, and was originally proposed in the Mohole Project. The principles of its operation are schematically shown and described. The system's ability to make holes of precise diameter could be utilized in producing holes for anchor structures such as bridges, TV towers, and transmission power lines. Emplacement holes for anchoring pipeline supports such as are required in the Alaskan permafrost are suggested. From the viewpoint of energy research and development, two specific areas for application involve the melting of holes in hot rocks for the extraction of geothermal energy and for developing underground superconducting transmission lines for electrical power. At present, such lines can only be laid in trenches that could be dug with considerable environmental disruption. A Subterrene horizontal hole could be melted with a minimum disturbance of the ground surface. (MCW)

5407 (ORNL-TM—4710) **Analytical study of elastical creep-fatigue design rules for ASME high-temperature code case.** Corum, J.M.; Sartory, W.K. (Oak Ridge National Lab., Tenn. (USA)). Aug 1975. Contract W-7405-eng-26. 44p. AT.

5408 (SAND—75-0543) **Mixed boundary value problems in potential theory for a cylindrical shell.** Keer, L.M.; Watts, H.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. Contract AT(29-1)-789. 16p. Dep. NTIS $3.50.

Two mixed boundary value problems for a semi-infinite cylindrical shell are solved. For both problems the normal derivative of the potential function is taken as zero on the inner and outer shell walls. The boundary conditions at the end of the shell are mixed with respect to the potential function and its normal derivative. The problems are formulated using integral transforms in a manner leading to a singular integral equation which can be solved by numerical means. Intensity factors along the circumference separating the mixed conditions are computed and compared with known limiting cases. (auth)

5409 (SAND—75-5362) **Three-dimensional structural analysis using interactive graphics.** Biffle, J.H.; Sumlin, H.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 23p. (CONF-751033—1). Dep. NTIS $4.25.

From Conference on applications of computer graphics in engineering; Hampton, Virginia, USA (1 Oct 1975).

The Sandia Interactive Graphics System (SIGS), which consists of a Vector General cathode ray tube, a DEC PDP-9 computer, a CDC 6600 computer, and an interactive graphics computer software system can effectively and efficiently process input and output data involved in 3-dimensional structural analysis using the finite element analysis technique. Input and output processing and applications of the SIGS are discussed. (LCL)

5410 (SAND—75-5643) **Comments on nonlinear transient structural analysis.** Stricklin, J.A.; Haisler, W.E.; Von Riesemann, W.A. (Texas Agricultural and Mechanical Univ., College Station (USA). Dept. of Aerospace Engineering; Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 21p. (CONF-751106—14). Dep. NTIS $4.50.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

The problem of nonlinear transient structural analysis is discussed. The various aspects of nonlinear analysis are discussed, including development of the governing equations, plasticity theory, and solution procedures. The underlying principle of virtual work is developed for the case of large strains in terms of both the true Cauchy stress and the 2nd Piola-Kirchhoff stress tensors. The pseudo force method is reviewed and detailed expressions are given for the pseudo force terms. For the case of large strains, the updated Lagrangian formulation is presented and discussed at length. Various numerical solution (temporal integration) procedures are reviewed. The shortcomings of current plasticity theories are discussed. Finally, numerical solutions for shells of revolution are presented to illustrate the type of nonlinear transient analyses currently being conducted. (auth)

5411 (SAND—75-5744) **Finite-element modeling of a parachute deployment and inflation.** Sundberg, W.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 9p. (CONF-751108—4). Dep. NTIS $4.00.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

A finite-element model has been developed which provides a detailed dynamic model for all points on a conventional

parachute during its deployment and inflation. Both canopy and suspension lines are modeled as two-dimensional, flexible, distributed-mass structures. The canopy is assumed to be axisymmetric, and the effect of this assumption is discussed. The change in canopy porosity with material stretch is considered. Aerodynamic forces are included on the suspension lines. Dynamic modeling for a lines-first deployment begins at a time when both canopy and suspension lines are stowed in an accordion-folded fashion in the deployment bag. The modeling includes line deployment, canopy unfurling, canopy inflation, and disreefing. Emphasis has been placed on the types of physical forces included, and the capability and generality allowed by the model. Some simple wave motion comparisons are included. A sample of the required data for parachute deployment modeling is given. Solutions obtained with the model show the tension wave motion which occurs during deployment and early inflation. (auth)

5412 (SAND—75-5993) **Analysis of the TATER nosetipe boundary layer transition and ablation experiment.** Hochrein, G.J.; Wright, G.F. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 10p. (CONF-760102—1). Dep. NTIS $4.50.

From 14. AIAA aerospace sciences meeting; Washington, District of Columbia, USA (26 Jan 1976).

The ATJ-S graphite nosetip boundary-layer transition and ablation experiment is described and analyzed. The experiment was performed during the ascending powered flight of the TATER rocket vehicle which reached a maximum velocity of 11.0 kfps and a freestream unit Reynolds number of 47.2 x 10^6/ft at an altitude of 11.6 kft. The instrumented nosetip was designed to measure the existence and behavior of boundary-layer transition on the nosetip and to obtain experimental recession and temperature data. The nosetip plug and frustum had an original nose radius of a 0.5 inch and a 9.0-degree cone half-angle. When recovered, the nosetip had ablated 0.567 in. and displayed a steady-state turbulent biconic shape along with scallop patterns. Stagnation-point recession and nosetip frustum temperature data were telemetered during the flight. Postflight measurements of the recovered nosetip provided quantitative shape change, roughness, and scallop data. The heat transfer and ablation models, which included the effects of scallop and roughness heating augmentation and shape change heating distributions, accurately predicted the nosetip shape and recession. Nosetip transition theories used in the analysis are in agreement with the time of transition deduced from the temperature data. Also the computed scallop parameters agree with the average measured values. (auth)

5413 (UCRL—51933) **LLL transient-electromagnetics-measurement facility.** Deadrick, F.J.; Miller, E.K.; Hudson, H.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Oct 1975. Contract W-7405-Eng-48. 32p. Dep. NTIS $4.00.

The operation and hardware of the Lawrence Livermore Laboratory's transient-electromagnetics (EM)-measurement facility are described. The transient-EM range is useful for determining the time-domain transient responses of structures to incident EM pulses. To illustrate the accuracy and utility of the EM-measurement facility, actual experimental measurements are compared to numerically computed values. (auth)

5414 (UCRL—51934) **LLL sphere-winding machine.** Mahler, J.P.; Bradley, R.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Oct 1975. Contract W-7405-Eng-48. 16p. Dep. NTIS $4.00.

To meet the needs of a National Aeronautics and Space Administration (NASA) research contract to determine optimum winding patterns for high-efficiency (maximum strength/minimum weight), composite-material, spherical pressure vessels, LLL has designed a highly flexible, computer-controlled filament-winding machine. This four-axis, fully programmable machine precisely winds filaments impregnated with polymeric material around spherical forms ranging from 8 to 40 cm (3 to 15 in.) in diameter. In addition, it allows winding patterns and parameters (e.g., pitch, position, bandwidth) to be changed quickly and easily, even during the winding operation. The desired change is simply entered into the unit's interactive, high-level language control program. (auth)

5415 (UCRL—77116(Rev.1)) **Three-dimensional stress distribution of a double-cantilever beam with a side notch.** Kirkwood, W.F.; Prado, M.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Nov 1975. Contract W-7405-Eng-48. 23p. (CONF-750836—2). Dep. NTIS $4.50.

From 9. national symposium on fracture mechanics; Pittsburgh, Pennsylvania, USA (25 Aug 1975).

The effect of a side notch used as a crack guide in a double-cantilever-beam specimen is investigated. The resulting stress distribution along the section of symmetry ahead of the notch is obtained from a three-dimensional photoelastic model. The effect of the side notch, through the thickness and down the side of the specimen is determined. After stress freezing, the model was sliced along principal planes. Along the x-x plane of symmetry, the principal stresses were determined by graphical integration of Filon's transformation of the Lame'-Maxwell equations and by subslicing along the x-z plane. Results of the investigation are in good agreement with those of other investigators. The side notch increases the value of the maximum tensile stress at the intersection of the starter notch and the side notch by approximately 22 percent. (auth)

5416 **Heat exchanger tube mounts.** Wolowodiuk, W.; Anelli, J.; Dawson, B.E. (to U.S. Atomic Energy Commission). US Patent 3,782,455. 1 Jan 1974. Filed date 1 May 1972. 6p.

PAT-APPL-248,842.

A heat exchanger in which tubes are secured to a tube sheet by internal bore welding is described. The tubes may be moved into place in preparation for welding with comparatively little trouble. A number of segmented tube support plates are provided which allow a considerable portion of each of the tubes to be moved laterally after the end thereof has been positioned in preparation for internal bore welding to the tube sheet. (auth)

5417 **Practicality of drilling rock with underwater sparks.** Alvis, R.L.; Milton, O. (Sandia Labs., Albuquerque, NM). pp 146-152 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—.

A spark drill was constructed and laboratory experiments conducted to determine areas requiring further investigation. As a result, more basic experiments were conducted to determine how a spark develops in a fluid and the material problems associated with a spark drill bit. Experimental results are given which show that the impedance of water drops quickly to a low value, expressions are given for energy deposition, and design approaches are suggested for an acceptable spark drill bit. (auth)

5418 **Drilling material concerns and methods.** Alvis, R.L.; Huff, C.F. (Sandia Labs., Albuquerque, NM). pp 1-9 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—(Suppl.).

Improved drilling is required for efficient exploration and production of our energy sources. Both conventional and new drilling systems are discussed, along with their associated material difficulties. The purpose of this paper is to air existing material problems in the hopes that solutions may be suggested by material researchers outside the drilling industry. (auth)

5419 **Self-adjusting load balancing pneumatic hoist.** Cobb, W.G. (to U.S. Energy Research and Development Administration). US Patent 3,894,476. 15 Jul 1975. Filed date 5 Apr 1974. 6p.

PAT-APPL-458,365.

A pneumatic hoist incorporating a load balancing system whereby a load supported by the hoist may be vertically repositioned by applying a relatively small force against the load in the direction of desired movement is described. The load balancing system utilizes a pressure regulator which is capable of continuously maintaining the pressure in the hoist to equal a reference pressure automatically established as required to balance the load and sealed in a pilot chamber of the regulator to provide for the vertical displacement of the load in response to a relatively small force applied in the direction of the desired movement. (auth)

5420 **Inlet flow distributor for a heat exchanger.** Harris, W.G. (to U.S. Energy Research and Development Administration). US Patent 3,895,674. 22 Jul 1975. Filed date 24 Feb 1972. 4p.

PAT-APPL-229,000.

To minimize pressure drop and optimize flow distribution, the inlet nozzle of a shell and tube heat exchanger for transferring heat from a liquid metal is disposed in an enlarged portion of the shell and has one or more flow distributors disposed to form an oblique angle with respect to the inlet nozzle and with respect to the tube. The flow distributor cooperates with either a sleeve enwrapping the tubes or a plurality of circular plates having one portion thereof cut away to distribute the incoming fluid evenly to all portions of the tube bundle so that the fluid flows lengthwise along the outer surface of the tubes. (auth)

5421 **Mechanically actuated temporary pump shaft maintenance seal.** Swearingen, J.S. (to U.S. Energy Research and Development Administration). US Patent 3,895,810. 22 Jul 1975. Filed date 15 Mar 1948. 4p.

PAT-APPL-14,858.

This patent describes a seal for establishing a temporary closure about a pump shaft to contain gases when the pump is being repaired. (auth)

5422 Mechanical drive for blood pump. Bifano, N.J.; Pouchot, W.D. (to U.S. Energy Research and Development Administration). US Patent 3,896,501. 29 Jul 1975. Filed date 2 Nov 1973. 6p.
PAT-APPL-412,397.

This patent relates to a highly efficient blood pump to be used as a replacement for a ventricle of the human heart to restore people disabled by heart disease. The mechanical drive of the present invention is designed to operate in conjunction with a thermoelectric converter power source. The mechanical drive system essentially converts the output of a rotary power into pulsatile motion so that the power demand from the thermoelectric converter remains essentially constant while the blood pump output is pulsed. (auth)

5423 Heat exchanger with a removable tube section. Wolowodiuk, W.; Anelli, J. (to U.S. Atomic Energy Commission). US Patent 3,896,873. 29 Jul 1975. Filed date 1 May 1972. 4p.
PAT-APPL-248,922.

A heat exchanger is described in which the tube sheet is secured against primary liquid pressure, but which allows for easy removal of the tube section. The tube section is supported by a flange which is secured by a number of shear blocks, each of which extends into a slot which is immovable with respect to the outer shell of the heat exchanger. (auth)

5424 Ultrasonic-acoustic grinding wheel setting station for automatic numerically-controlled machines. Henry, J.J. (to U.S. Energy Research and Development Administration). US Patent 3,897,659. 5 Aug 1975. Filed date 30 Aug 1974. 6p.
PAT-APPL-501,899.

A precisely machined metal ball is supported at a reference position on a numerically controlled grinding machine. The ball is displaceably carried by a metal holder having a conical shaped seat machined to support the ball. The holder is mounted at the reference position on the machine by means of a phenolic support to attenuate extraneous ultrasonic vibrations induced in the machine base. A piezoelectric crystal is acoustically coupled to the ball holder to sense ultrasonic vibrations induced in the ball and transmitted through the holder when the grinding wheel touches the reference ball. The ultrasonic frequency electrical signal output of the crystal is sensed by an ultrasonic detection circuit which produces a dc output signal having an amplitude proportional to the ultrasonic signal amplitude. The dc signal may be used to signal the numerical controller to stop the grinding wheel positioning mechanism when a predetermined level dc signal is sensed to indicate that the grinding wheel is positioned at the reference point along the axis. (auth)

5425 Valve for cryogenic service. Worwetz, H.A. (to U.S. Energy Research and Development Administration). US Patent 3,902,695. 2 Sep 1975. Filed date 13 Dec 1973. 4p.
PAT-APPL-424,257.

This patent relates to a valve for use with a liquefied gas at cryogenic temperatures in which a pair of joined knife edges are bellows controlled to contact an indium alloy seat in an annular slot when flow is to be stopped. The sealing alloy may be renewed by heating in situ. (auth)

5426 Calibration block. Sundahl, E.G. (to U.S. Energy Research and Development Administration). US Patent 3,908,278. 30 Sep 1975. Filed date 21 Mar 1974. 6p.
PAT-APPL-453,604.

This patent relates to a calibration block which includes a number of stepped surfaces arranged in an upward, spiral-like sequence and accurately dimensioned from a single base surface, each of these stepped surfaces having one recessed groove across the innermost margin thereof. The base surface is of precision flatness in order to be brought into adhesive contact with a companion block of precision measurements. A corner of the calibration block is removed to provide access to the companion block as a reference point. (auth)

5427 Vibrations of a row of circular cylinders in a liquid. Chen, S.S. (Argonne National Lab., IL). *J. Eng. Ind.*; 97: No. 4, 1212-1218(Nov 1975).

From American Society of Mechanical Engineers technical conference; Washington, DC, USA (17 Sep 1975).

The effects of interaction with surrounding liquid on the dynamic behavior of a row of circular cylinders were studied analytically. The hydrodynamic forces associated with cylinder motions were obtained using the potential flow theory and a method of solution is presented for free and forced vibrations of a row of cylinders. The results of this study have important application in the modeling of crossflow-induced vibration of heat-exchanger tubes. (auth)

5428 Aerosol generator of high stability. Liu, B.Y.H.; Lee, K.W. (Univ. of Minnesota, Minneapolis). *Am. Ind. Hyg. Assoc. J.*; 36: No. 12, 861-865(Dec 1975).

The use of a syringe pump to provide a constant liquid flow to an atomizer to obtain an aerosol generator of high stability is reported. This syringe-pump atomizer has also been used with a vaporizer-condenser to generate monodisperse di-octyl phthalate (DOP) aerosols in the 0.032 to 1 μm diameter range. (auth)

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

5429 (CONF-751113—5) Dielectric breakdown in liquid helium. Miller, F.L. Jr. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1975. 9p. Dep. NTIS $4.50.

From 1. ERDA statistical symposium; Los Alamos, New Mexico, USA (3 Nov 1975).

The experimental apparatus consists of a 130 kV dc 80 kV ac intermediate voltage unit and a 600 kV dc 700 kV high voltage unit under construction. The experimental devices consist of an insulated container, or dewar, in which two electrodes are placed, one above the other. A voltage is built up in one electrode until an arc occurs to the other electrode. A typical set of breakdown data is shown. A mathematical analysis is briefly described. (MOW)

5430 (CONF-751125—37) Propagation of normal zones in composite superconductors. Dresner, L.; Miller, J.R.; Donaldson, G.W. (Oak Ridge National Lab., Tenn. (USA)). 1975. 6p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Propagation velocities of normal zones in a multifilamentary composite conductor were measured for a range of magnetic fields and operating currents. The degree of thermal contact of the conductor with the helium bath was varied, the conductor having been bare, insulated by a thin Formvar layer, or completely potted in wax. The measurements were compared with theory, and good agreement was achieved by suitably choosing the heat transfer coefficient. (auth)

5431 (COO—2522-1) Improved superconductor for transmission line applications, phase I. Final report, January 1, 1975—June 30, 1975. Braginski, A.I.; Mauser, S.F.; Roland, G.W.; Burghardt, R.R.; Daniel, M.R.; Janocko, M.A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). 1975. Contract E(11-1)-2522. 133p. Dep. NTIS $7.00.

The analysis of an existing superconducting power transmission cable design indicated that economic benefits in the area of refrigeration can be derived from the substitution of Nb_3Ge superconductor for the presently planned Nb_3Sn. However, the cost of Nb_3Ge must be comparable to that of Nb_3Sn, which is achievable when preparing Nb_3Ge by the chemical vapor deposition. Alternatively, technical benefits can be obtained. The most essential and prerequisite requirement is that the Nb_3Ge critical current density be improved significantly over the present state-of-the art. Other properties of Nb_3Ge are generally suitable for the transmission line application and/or require only moderate improvements. (auth)

5432 (LA—6117-PR) Superconducting magnetic energy storage project at the Los Alamos Scientific Laboratory. Progress report, January 1—March 31, 1975. Hassenzahl, W.V. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-eng-36. 15p. Dep. NTIS $4.00.

Details are reported on the design of a 100-MJ superconducting magnetic energy storage system. Superconducting wire of a type which may be used in the 100-MJ model has been ordered and a small test coil has been designed to test the wire and the winding technique to be used on the 100-MJ coil. (auth)

PROTECTIVE STRUCTURES AND EQUIPMENT

5433 (SC-DC—68-2288) Discussion of rocket vehicle joint characteristics. Weydert, J.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1 May 1968. 22p. Dep. NTIS $4.50.

Joints for rocket vehicles must be considered as necessary evils. It is practically impossible to introduce a joint into a structural system without a degrading effect. Therefore, it is important to apply joints of such design that the system performance is least affected. Some of the rocket physical and flight parameters which are affected by the presence of joints are: (1) increased weight, thus reducing performance; (2) reduced useful internal volume; (3) change of structural natural frequency; (4) increased airloads; (5) greater trajectory disperison by elasticity effect; (6) higher

structural loads; (7) reduced apogee due to greater vehicle flexing; (8) change in aerodynamic pitch frequency; (9) reduced static stability margin; and (10) unknown complex aerodynamic and dynamic effects. The design and performance characteristics of several joints are discussed. (TFD)

5434 (SC-TM—71-0257) **Shrapnel containment shields.** Hartwigsen, C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1971. 15p. Dep. NTIS $4.00.

Experience with lightweight Lexan/Safety Glass shrapnel shields for use on explosives assembly benches are discussed. A method for laminating the two materials and the results of firing tests are presented. (auth)

5435 (UCRL—52000-75-10) **Lawrence Livermore Laboratory energy and technology review.** Carr, R.B.; McCaleb, C.S.; Prono, J.K. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1975. Contract W-7405-Eng-48. 30p. Dep. NTIS $5.00.

Separate abstracts were written for the four sections of the report. One section was included in ERDA Research Abstracts but not in Nuclear Science Abstracts. (SFL)

5436 (UCRL—52000-75-10, pp 11-14) **Safety limits of half-mask cartridge respirators for organic solvent vapors.** Oct 1975.

In Lawrence Livermore Laboratory energy and technology review.

Recent studies of the effective service life (safety limits) for typical half-mask cartridge respirators have shown these devices to be unsuitable for certain organic vapors, e.g., methanol, methylamine, vinyl chloride, and dichloromethane, because the effective service life is too short. For these vapors other forms of protection such as air-supplied respirators are recommended. The experimentally determined service life for many vapors is shorter—sometimes significantly shorter—than predicted by adsorption theory. (auth)

HANDLING EQUIPMENT AND PROCEDURES

5437 (CONF-751029—1) **Master—slave manipulators and remote maintenance at the Oak Ridge National Laboratory.** Jenness, R.G.; Wicker, C.D. (Oak Ridge National Lab., Tenn. (USA)). 1975. 9p. Dep. NTIS $4.00.

From National bureau of standards workshop; Annapolis, Maryland, USA (23 Oct 1975).

The volume of master-slave manipulator maintenance at Oak Ridge National Laboratory has necessitated the establishment of a repair facility and the organization of a specially trained group of craftsmen. Emphasis on cell containment requires the use of manipulator boots and the development of precise procedures for accomplishing the maintenance of 283 installed units. To provide the most economical type of preventive maintenance, a very satisfactory computer-programmed maintenance system has been established at the Laboratory. (auth)

5438 (CONF-751101—23) **Comments on the use of the Monte Carlo method for criticality calculations.** Whitesides, G.E. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1975. 5p. Dep. NTIS $4.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

As evidenced by recent papers given at Nuclear Criticality Safety Division meetings, the use of the Monte Carlo method has become a very popular computational tool. The ease of use has undoubtably been a primary reason for this popularity. This ease of use, however, may lead to a false sense of security when using the method. Guidance on the effective use of the method and some suggestions on how to avoid some of the pitfalls that can occur are presented. (TFD)

SHIPPING CONTAINERS

5439 (SAND—75-5658) **Spent and fresh fuel shipping cask considerations.** Shappert, L.B.; Unger, W.E.; Freedman, J.M. (Oak Ridge National Lab., Tenn. (USA); Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 18p. (CONF-751101—24). Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

A program to provide basic information for cask design and safety has been conducted for over ten years at Oak Ridge National Laboratory. Principal problem areas in Liquid Metal Fast Breeder Reactor (LMFBR) casks are identified as heat transfer, structures and containment, criticality and shielding. Solutions in the problem areas, as well as the need for future work, are addressed by describing an LMFBR conceptual design cask. A new program, which is underway at Sandia Laboratories, Albuquerque, New Mexico, is aimed at producing technology useful to industry and government. Technologies are being developed in areas of hazards analysis, heat transfer, shielding, structures and containment, and spent fuel characterization, substantiated by hot laboratory verification. Particular emphasis will be placed on establishing qualification tests based on accident experience. Handling requirements and limitations are discussed. (auth)

LASERS

5440 (LA-UR—75-1832) **Pulse forming networks for fast pumping of high power electron-beam-controlled CO_2 lasers.** Riepe, K.B. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-eng-36. 10p. (CONF-751102—1). Dep. NTIS $4.00.

From International laser exposition and electro-optics '75; Anaheim, California, USA (11 Nov 1975).

The transverse electric discharge is a widely used technique for pumping CO_2 lasers at high pressures for the generation, simply and efficiently, of very high power laser pulses. The development of the electron-beam-controlled discharge has allowed the application of the transverse discharge to large aperture, very high energy systems. LASL is now in the process of assembly and checkout of a CO_2 laser which is designed to generate a one nanosecond pulse containing 10 kilojoules, for use in laser fusion experiments. The front end of this laser consists of a set of preamplifiers and a mode locked oscillator with electro-optic single pulse switchout. The final amplifier stage consists of four parallel modules, each one consisting of a two-sided electron gun, and two 35 x 35 x 200 cm gas pumping regions operating at a pressure of 1800 torr with a $3/^1/_4/1$ ($He/N_2/CO_2$) laser mix. (auth)

5441 (SAND—75-0492) **Laser feedback calculations.** Brannon, P.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. Contract AT(29-1)-789. 10p. Dep. NTIS $4.00.

A straightforward analysis of the frequency effects of laser light reflected back into the laser is given. A simple three-mirror system is analyzed, but the method can be applied to any complex mirror system. (auth)

5442 (SAND—75-5629) **Pulse power technology application to lasers.** Prestwich, K.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 23p. (CONF-751102—3). Dep. NTIS $4.50.

From International laser exposition and electro-optics '75; Anaheim, California, USA (11 Nov 1975).

Recent developments of intense relativistic electron beam accelerators and the associated pulse power technology are reviewed. The design of specific accelerators for gas laser excitation sources is discussed. A 3 MV, 800 kA, 24 ns electron beam accelerator under development for the electron beam fusion program is described along with the low jitter multichannel oil-dielectric rail switches developed for this application. This technology leads to the design of a 20 kJ, short pulse accelerator optimized gas laser excitation with radially converging electron beams. Other gas laser research requirements have led to the development of an accelerator that will produce a 0.5 MV, 20 kJ, 1 μs electron beam pulse. (auth)

5443 (UCID—16925) **Effect of optical systems on diffraction.** Weaver, H.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Jul 1973. Contract W-7405-Eng-48. 16p. Dep. NTIS $4.00.

A relationship (isomorphism) that exists between coherent optical systems with and without lenses is described. This relationship turns out to be very simple and very useful for the design and analysis of laser optical systems. The isomorphism is derived by Fourier analyses. A study of various optical configurations is presented and several examples are given. (auth)

5444 (UCID—16926) **Beam shaping and propagation study for the kilojoule laser system.** Weaver, H.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1973. Contract W-7405-Eng-48. 36p. Dep. NTIS $5.00.

The radial energy density profile of a laser beam that is to be injected into the kilojoule laser system must be such that diffraction effects, which may lead to self-focusing, are minimized while at the same time energy extraction is maximized. Although the two effects are interrelated they are discussed separately for the sake of clarity. (auth)

5445 (UCID—16930) **Flowing dye cell and pump system for mode-locked oscillator.** Pierce, E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 May 1972. 11p. Dep. NTIS $4.00.

A description of a small, inexpensive pump system and flowing dye cell for use in a mode-locked laser oscillator is given. (auth)

5446 (UCID—16935) **Kinetic modeling of photodissociation iodine laser amplifiers.** Turner, C.E. Jr.; Rapagnani, N.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Oct 1974. Contract W-7405-Eng-48. 26p. (CONF-7210134—1). Dep. NTIS $5.00.

From 4. conference on chemical and molecular lasers; St. Louis, Missouri, USA (21 Oct 1972).

A comprehensive kinetic model is described which predicts the time dependence of the inversion in iodine-laser energy-storage amplifiers over a wide range of helium diluent pressure. The high rare gas pressures (1-10 atm), which are required to suppress superfluorescence and produce bandwidths suitable for short generation via collision broadening, significantly modify the chemical kinetics of the flash photolysis of fluorinated alkyl iodides (RI, e.g., CF_3I, C_2F_5I) because of lower temperature rise, fast thermalization of "hot" radicals and three-body effects. The model includes many of the typical two-body deactivation, recombination and reaction mechanisms previously considered for low pressure analyses but it is appropriate to omit some uncertain reactions involving "hot" radicals. In addition, it is necessary to consider I_2 formation via three-body iodine atom recombination: (a) I + I + M, (b) I* + I + M, and (c) I* + I* + M, where the main catalysts (M) are He, I_2 and RI. (auth)

5447 (UCID—16960) **Faraday Rotator 5 kV Capacitor Bank.** Fetterman, C.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Nov 1975. Contract W-705-eng-48. 25p. Dep. NTIS $4.00.

A Faraday rotator 5 kV capacitor bank is a pulsed output power supply used to energize Faraday rotators for optical isolation in the "LLL kJ Glass Laser System." Each supply contains either one, two or three parallel 240 μF storage capacitors depending on the size of the isolator used. Generally, the "A*"(216 μH) isolator is energized with one capacitor, the "A"(116 μH) isolator uses two capacitors and the "B"(87 μH) isolator requires three capacitors. All models of isolators have been tested with four capacitors under maximum voltage and 25 feet of RG-217 cable with no hazardous effects. Except for the number of capacitors in each unit, the supplies are otherwise physically identical. (TFD)

5448 (UCRL—76958) **Oxygen auroral transition laser system excited by collisional and photolytic energy transfer.** Murray, J.R.; Powell, H.T.; Rhodes, C.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1975. 11p. (CONF-7506103—1). Dep. NTIS $4.50.

From Conference on laser spectroscopy; Megeve, France (23 Jun 1975).

The properties of laser media involving the auroral transition of atomic oxygen and analogous systems are examined. A discussion of the atomic properties, collisional mechanisms, excitation processes, and collisionally induced radiative phenomena is given. Crossing phenomena play a particularly important role in governing the dynamics of the medium. (auth)

5449 (UCRL—77480) **Mechanical design, materials selection, fabrication and assembly of ultraclean, high-gain, Nd: glass disk laser amplifiers.** Fountain, W.D.; Ker, K.; Holl, P.; Bubp, D.; Neef, W.S. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Nov 1975. Contract W-7405-Eng-48. 7p. Dep. NTIS $4.50.

Particulate contamination in disk amplifiers with high flashlamp fluxes (which can generate particles) causes three types of laser beam obscuration, which cause small-scale self-focusing. Methods for obtaining disk amplifiers that stay clean are described. (auth)

5450 (UCRL-Trans—10946) **Pressure broadening of the 1.3 um iodine laser line.** Fuss, W.; Hohla, K. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (F.R. Germany)). Dec 1974. Translation of IPP—IV/67. 43p. Dep. NTIS $5.00.

Storable energy of a high energy laser is inversely proportional to its stimulated emission cross-section sigma. By adding a foreign gas, the emission line is broadened and sigma is thereby lowered. The sigma of the iodine laser as a function of pressure of several gases (Ar, N_2, CO, CO_2, SF_6, CF_3Br, C_3F_7J, CF_2Cl_2 $(CF_3)_2CO$) by an absolute and a relative method. 1/sigma is a linear function of pressure in spite of the fact that overlapping of the hyperfine structure components varies considerably in the range investigated. For energy storage, CO_2 is a good compromise between pressure broadening and chemical deactivation of the excited I atoms. At one atmosphere of CO_2, 5 to 7 J cm^{-2} can be stored, hyperfine structure is extensively blurred, and amplification of pulses shorter than 100 psec should be possible. (auth)

5451 **Quantum yields for the production of O(^{1}S), N(^{2}D), and N_2(A $^3\Sigma$/sub u/$^+$) from the vacuum uv photolysis of N_2O.** Black, G.; Sharpless, R.L.; Slanger, T.G.; Lorents, D.C. (Stanford Research Inst., Menlo Park, CA). *J. Chem. Phys.*; 62: No. 11, 4266-4273(1 Jun 1975).

Relative quantum yields have been measured for O(^{1}S), N(^{2}D), and N_2(A $^3\Sigma^+$/sub u/) production from N_2O over the wavelength range 1100-1500 A. The measurements of O(^{1}S) were made by observing the $^1S_0$ yields $^1D_2$ emission at 5577 A. N(^{2}D) was measured via the intensity of NO β bands generated by N(^{2}D) + N_2O yields N_2 + NO(B $^2\pi$/sub r/) followed by NO(B $^2\pi$/sub r/) yields NO(X $^2\pi$/sub r/) + hν(NO β bands). The N_2(A $^3\Sigma^+$/sub u/) was measured by the intensity of NO γ bands generated by N_2(A $^3\Sigma^+$/sub u/) + NO yields N_2 + NO(A $^2\Sigma^+$) followed by NO(A $^2\Sigma^+$) yields NO + hν (NO γ bands). The O(^{1}S) quantum yield is close to unity over the 1280-1380 A wavelength range. N(^{2}D) exhibits a large yield for lambda less than or equal to 1200 A. The quantum yield of N_2(A $^3\Sigma^+$/sub u/) is less than or equal to 0.2 over the entire 1100-1500 A region. (auth)

5452 **Quantum yields for the production of S(^{1}S) from OCS (1100-0700 A).** Black, G.; Sharpless, R.L.; Slanger, T.G.; Lorents, D.C. (Stanford Research Inst., Menlo Park, CA). *J. Chem. Phys.*; 62: No. 11, 4274-4277(1 Jun 1975).

The 4589 A emission of S($^1S_0$) has been used to measure the quantum yields of S($^1S_0$) production from OCS over the wavelength interval 1100-1700 A. A large yield is found from 1420 to 1600 A with smaller yields being observed at both shorter and longer wavelengths. (auth)

5453 **Effect of rotational and intramode vibrational coupling on short-pulse amplification in CO_2.** Harrach, R.J. (Univ. of California, Livermore). *IEEE J. Quant. Electron.*; QE-11: No. 7, 349-357(Jul 1975).

The extraction of stored energy from a CO_2-laser amplifier by a short-duration input pulse is described using a rate-equation theory. The influence of rotational and intramode vibrational energy-transfer processes is studied as a function of the energy density E/sub in/ and width tau/sub p/ of the input pulse. By a suitable choice of normalized variables delta and E/sub in//E/sub sat/ for the extracted-energy and input-energy density, it is found that the results for different values of tau/sub p/ are interrelated by simple translations in a delta versus E/sub in//E/sub sat/ diagram. The characteristic curves in this diagram are nearly independent of the amplifier gain factor exp (α_0L) for high-gain systems. A comparison of the theory with experimental results of Figueira et al. shows satisfactory agreement and leads to an estimate of (1.0—3.5) 10^6 s^{-1} $torr^{-1}$ for the rate of intramode vibrational-vibrational energy transfer in CO_2. (auth)

5454 **Amplification of the 1.32 μm line in Nd:YAG.** Loree, T.R.; Sherman, L.M.; Thorne, J.M. (Los Alamos Scientific Lab., NM). *IEEE J. Quant. Electron.*; QE-11: No. 7, 371-372(Jul 1975).

Single-pass amplifier gains at 1.32 μm have been measured in an 80-mm Nd:YAG rod, achieving a saturated gain of 3.1. Small-signal gain comparisons imply a stimulated-emission cross-section ratio (1.32/1.06 μm) of 0.19. (auth)

5455 **Ultraviolet ion laser performance and spectroscopy. I. New strong noble-gas transitions below 2500 A.** Marling, J.B. (Univ. of California, Livermore). *IEEE J. Quant. Electron.*; QE-11: No. 10, 822-838(Oct 1975).

The performance and spectroscopy of UV ion lasers have been investigated to 1850 A, the limit of available mirrors. New anomalously strong transitions of about 1-kW peak power were found in Xe IV. at 2315.357 A and Kr IV at 2191.916 A. The shortest wavelength new laser transition was Kr IV at 1949.623 A. Wavelengths were measured for 25 new and many previously known UV laser transitions to about 0.006 A. Optimum output in watts was also measured as a function of bore current density and gas pressure. All measurements were taken from a 7-mm-bore 150-cm-arc length tube designed for low electrical inductance providing current excitation pulses with 250-ns full width at half maximum (FWHM). (auth)

5456 **Time-resolved output spectrum from a hydrogen fluoride laser using mixtures of SF_6 and HI.** Greiner, N.R. (Las Alamos Scientific Lab., NM). *IEEE J. Quant. Electron.*; QE-11: No. 10, 844-845(Oct 1975).

The time-resolved spectrum from a transverse-discharge hydrogen fluoride (HF) laser using a mixture of SF_6 and HI is reported. Because this spectrum matches that from a high-pressure H_2-F_2 laser, and because the SF_6-HI mixture is chemically stable, this laser should be a suitable and convenient source for probing H_2-F_2 amplifiers. (auth)

5457 Induced-emission cross sections for the ^{4}F/sub 3/2/ yields ^{4}I/sub 13/2/ transition in neodymium laser glasses. Jacobs, R.R.; Weber, M.J. (Univ. of California, Livermore). *IEEE J. Quant. Electron.*; QE-11: No. 10, 846-847(Oct 1975).

Induced-emission cross sections for the ^{4}F/sub 3/2/ yields ^{4}I/sub 13/2/ transition of Nd^{3+} in several commercial and experimental laser glasses have been determined using spectroscopic data and the Judd-Ofelt treatment of electric-dipole transition probabilities. (auth)

5458 Mixed metal vapor phase matching for third-harmonic generation. Bloom, D.M.; Young, J.F.; Harris, S.E. (Stanford Univ., CA). *Appl. Phys. Lett.*; 27: No. 7, 390-392(1 Oct 1975).

Phase matching for frequency tripling of 1.06 μm is demonstrated in a homogeneous mixture of sodium and magnesium vapor. The ratio of Mg to Na vapor pressures required for phase matching is 2:1. This ratio is about $^1/_{75}$ of that required to phase match Na with Xe. (auth)

HEAT TRANSFER AND FLUID FLOW

5459 (CONF-751106—13) Characteristics and stability analyses of transient one-dimensional two-phase flow equations and their finite difference approximations. Lyczkowski, R.W.; Gidaspow, D.; Solbrig, C.W.; Hughes, E.D. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 62p. Dep. NTIS $5.50.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

Equation systems describing one-dimensional, transient, two-phase flow with separate continuity, momentum, and energy equations for each phase are classified by use of the method of characteristics. Little attempt is made to justify the physics of these equations. Many of the equation systems possess complex-valued characteristics and hence, according to well-known mathematical theorems, are not well-posed as initial-value problems (IVPs). Real-valued characteristics are necessary but not sufficient to insure well-posedness. In the absence of lower order source or sink terms (potential type flows), which can affect the well-posedness of IVPs, the complex characteristics associated with these two-phase flow equations imply unbounded exponential growth for disturbances of all wavelengths. Analytical and numerical examples show that the ill-posedness of IVPs for the two-phase flow partial differential equations which possess complex characteristics produce unstable numerical schemes. These unstable numerical schemes can produce apparently stable and even accurate results if the growth rate resulting from the complex characteristics remains small throughout the time span of the numerical experiment or if sufficient numerical damping is present for the increment size used. Other examples show that clearly nonphysical numerical instabilities resulting from the complex characteristics can be produced. These latter types of numerical instabilities are shown to be removed by the addition of physically motivated differential terms which eliminate the complex characteristics. (auth)

5460 (SAND—75-5478) Parametric study of parachute pressure distribution by wind tunnel testing. Pepper, W.B.; Reed, J.F. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 24p. (CONF-751108—3). Dep. NTIS $4.25.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

Pressure distribution data for solid and ribbon parachutes are presented. Three-foot dia model parachutes of 0, 10, 15, 20, 25, 30, and 40 percent geometric porosity were tested. Suspension line lengths of 1.0, 1.5, and 2.0 constructed dias were used. Reefing line lengths of 19, 38, and 57-in. were tested. Two 7 x 10-ft. wind tunnels were used to test over a range of dynamic pressure from 35 to 600 lb/ft^2. Integration of the measured pressures over the inflated canopy profiles generally resulted in drag force values which agree within 10 percent of force balance drag data. (auth)

5461 Forced convection heat transfer with two-phase flow. Williamson, K.D. Jr.; Edeskuty, F.J. (Los Alamos Scientific Lab., NM). pp 261-278 of In Heat transfer at low temperatures. Frost, W. (ed.). New York; Plenum Publishing Corp. ([nd]).

A number of correlations to represent forced convection heat transfer to two-phase cryogenic fluids are presented. In most cases these were developed from limited data for a single fluid (most often hydrogen). Only one critical evaluation and comparison was made. It should be noted that this evaluation is based only on hydrogen data and that the nucleate boiling portion is based on only 19 data points. Specific recommendations for general use of the equations have not been made because of a lack of generality in their development and the paucity of data. To determine the applicability of any of these correlations with fluids other than those for which they were developed, much more data are required. For cryogens, this should include liquefied methane (liquefied natural gas) nitrogen, oxygen, and helium. While liquid nitrogen and liquid oxygen are already common engineering materials, the rapid growth of the technology of liquefied natural gas and liquid helium presents a real need for more engineering data. (LCL)

5462 Dense-fluid shear viscosity via nonequilibrium molecular dynamics. Ashurst, W.T. (Sandia Labs., Livermore, CA); Hoover, W.G. *Phys. Rev., A;* 11: No. 2, 658-678(Feb 1975).

A novel fluid-transport calculation by computer simulation, via nonequilibrium molecular dynamics, of laboratory methods of transport measurement is described. Shear viscosity of soft-sphere (r^{-12} potential) and Lennard--Jones particles ($r^{-12} - r^{-6}$ potential) has been obtained from molecular dynamic modeling of Couette flow. Soft-sphere deviations from Enskog theory are similar to those found for hard spheres by Alder, Gass, and Wainwright, using time-correlations of equilibrium molecular dynamic system fluctuations. For the Lennard--Jones shear viscosity near the triple-point region, there is agreement between the equilibrium calculation of Levesque, Verlet, and Kurkijarvi and the nonequilibrium results using 108 atoms in a cube. However, systems two and three cubes wide give lower results, which, when extrapolated with inverse width, yield close agreement with the experimental argon shear viscosity. Comparison of the Lennard-Jones shear viscosity with experimental argon data along the saturated vapor-pressure line of argon confirms our successful simulation of macroscopic viscous flow with few-particle nonequilibrium molecular dynamic systems. A new result of the nonequilibrium molecular dynamics is the characterization of nonequilibrium distribution functions, which might provide the basis for a perturbation theory of transport. Since momentum transport is primarily accomplished by the repulsive potential core for high temperatures, the Lennard-Jones shear viscosity must behave like the soft-sphere system for high temperatures [viscosity divided by (temperature)/sup 2/3/ is a function of density divided by (temperature)/sup 1/4/]. In fact, the calculated excess shear viscosity (that part above the zero-density temperature dependence) has been successfully correlated in terms of the 12th-power scaling variables for temperatures as low as the critical value (along the freezing line). (auth)

MATERIALS TESTING

5463 (AECL—5241) Pitfalls in the use of noise suppression in ultrasonic flaw detection. Coote, R.I.; Long, J.H.C. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Oct 1975. 15p. Dep. NTIS (US Sales Only) $4.50. AECL $0.50.

The effects of the noise suppression control on two ultrasonic test instruments, a Krautkramer USIP 11 and a Branson 303 have been documented by checking the amplifiers' vertical linearity, the accuracy of the calibrated gain controls, and the resulting effect on defect signals. Although a calibration signal can be maintained at a constant level when noise suppression is used, it is found that significant defect signals are reduced in amplitude or eliminated completely. It is recommended that the use of noise suppression be avoided unless an additional calibration defect is used to define the minimum signal level of interest. (auth)

5464 (DP-MS—75-86) Neutron radiographic detection limits of fluids in metal pipes. Winn, W.G. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 29p. (CONF-751016—4). Dep. NTIS $4.50.

From Conference of the American Society for Nondestructive Testing, Inc.; Atlanta, Georgia, USA (13 Oct 1975).

Thermal neutron radiography has been used to image thin films of various fluids in thick-walled high-pressure process pipes. A 3.5 x 10^6 n/(cm^2-sec) thermal neutron beam and standard transfer imaging techniques were used to provide radiographs of the fluid-bearing pipes. In addition, a computer graphics procedure was developed which simulated the neutron radiographs; this method permitted examination of some fluid-pipe configurations not studied experimentally. Actual pipe outer dia ranged from $^1/_4$ to $^9/_{16}$ in. (OD/ID = 3), but the graphics method was used for some cases outside this range. Fluids in the thermal cross section range 0.29 cm^{-1} less than or equal to Σ/sub th//sup f/ less than or equal to 3.47 cm^{-1} were examined for pipes with 0.099 cm^{-1} less than or equal to Σ/sub th//sup p/ less than or equal to 1.15 cm^{-1}. For Σ/sub th//sup f/ greater than Σ/sub th//sup p/, the smallest measured film thickness t/sub s/ varied 0.006 to 0.040 in. with decreasing Σ/sub th//sup f/; a semiempirical model described t/sub s/ = t/sub r/ + t/sub a/, where t/sub r/ corresponded to resolution and t/sub a/ depended on the bulk attenuation strength of the fluid. For Σ/sub th//sup f/ less than Σ/sub th//sup p/, part of the

fluid film t/sub m/ was masked by the pipe. The calculated physical film thickness t/sub p/ = t/sub a/ + t/sub m/ ranged from 0.003 to 0.035 in. for smallest detected fluid films. Detection of low Σ/sub th/ fluids was improved as much as 60 percent when the pipes were tilted 60° toward the neutron beam. Other options for improved detection were investigated using simulated radiographs. (auth)

5465 Use of the torsional pendulum in material characterization. Quant, A.J. (Sandia Labs., Albuquerque, NM). pp 459-465 of In Materials review '75. Azusa, CA; Society for the Advancement of Material and Process Engineering (1975).

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

See CONF-751005—.

The mechanical behavior of many materials can be readily characterized by use of the torsional pendulum. The data obtained, shear modulus and damping decrement, provide elastic and inelastic parameters, and are generally representative of a material's mechanical behavior. The test specimen is easily prepared and the test procedure is readily performed over a wide temperature range. From a plot of such data, one can accurately predict mechanical behavior as a function of temperature. Transition temperatures where significant behavioral changes occur are clearly established. (auth)

VACUUM ENGINEERING

5466 (ERDA-tr—71) Analysis of molecular flow parameters with the help of kinetic Vallander equations. Ershov, B.D.; Saksaganskii, G.L. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). 1973. Translation of NIIEFA-A—0182. 18p. Dep. NTIS $4.00.

A technique is given for calculating the macroscopic parameters of a molecular flow and the capture coefficients of vacuum structures with sorbing walls. The basic analytical relationships and diagrams are presented. The possible advantages of the proposed method in comparison with the Monte Carlo method and methods based on the theory of radiant heat exchange are discussed. (auth)

5467 (ERDA-tr—72) Gas-kinetic analysis of multicomponent vacuum systems by the method of equivalent surfaces. Ershov, B.D.; Sakaganskii, G.L. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). 1974. Translation of NIIEFA-A—0219. 16p. Dep. NTIS $4.00.

A method is proposed for the analysis of molecular flows in complicated vacuum systems. Essentially, it involves the transposition of solutions for a number of elemental structural components. The basic analytic relationships and tables are given and the method is illustrated by analyzing a specific system. (auth)

ELECTRONIC CIRCUITS AND DEVICES

5468 (CEA-N—1811) Cooled system for measuring the degree of stabilization (error in operation) of a continuous supply from multisources (less than or equal to 6) versus the load, voltage, and temperature. Ringeard, C.; Vuillemin, J.C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services d'Electronique). 23 May 1975. 32p. (In French). INIS.

The SAMAS 6 System is principally intended for the measurement of regulated power supply load, voltage regulation, and temperature coefficient. Six power supplies can be simultaneously measured. A program runs the measurement cycle, supplies the results on a teleprinter and estimates the accuracy measurement. (auth)

5469 (NP—20733) Programmed device for the measurement of the "degree of stabilization" (functioning error) of a continuous multisource power supply (less than or equal to 6) as a function of the variations of the network voltage, output yield, and temperature. SAMAS 6 System. Ringeard, C.; Vuillemin, J.C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services d'Electronique). 25 Jan 1975. 37p. (In French). Dep. NTIS (US Sales Only) $5.00.

The SAMAS 6 System is principally intended for the measurement of regulated power supply load, voltage regulation, and temperature coefficient. Six power supplies can be simultaneously measured. A program operates the measurement cycle, supplies the results on a teleprinter, and estimates the measurement accuracy. (auth)

5470 (PEM—45) Cable and connector shielding attenuation and transfer impedance measurements using quadraxial and quintaxial test methods. Madle, P.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1975. 23p. Dep. NTIS $4.50.

The relations between the shielding attenuation, the transfer impedance and the shielding effectiveness of an assembly of shielded cables and connectors are discussed. Six possible shielding attenuation test methods, i.e., open wire, coaxial, inverted triaxial, quadraxial, and quintaxial, are described and their advantages, disadvantages and limitations are discussed. The use of the quintaxial test method is illustrated by a limited amount of test data obtained on several types of standard coaxial cable. The samples tested were of approximately 75 cm length and ranged from approximately 0.2 cm to 0.5 cm in dia. The frequency range of the tests extended from 0.1 MHz to 3,000 MHz. (auth)

5471 (SAND—75-0285) Thermal and mechanical limit study for Sandia Laboratories Generation I and II hybrid microcircuit technology. Olson, H.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. Contract AT(29-1)-789. 63p. Dep. NTIS $5.45.

Samples of chip capacitors epoxied to chrome-gold metallized substrates using thermocompression bonded 2.54 x 10^{-2} mm gold flying wire interconnections; thermocompression bonded integrated circuits; wire and ribbon thermocompression bonded crossovers; and soldered chip capacitors were subjected to the mechanical and thermal environments as specified in MIL-STD-883, method 5006, "Limited Testing." In addition, some samples were aged at 150°C for 1000 h prior to experiencing the environmental test series. The purpose for "Limit Testing" is to establish the maximum mechanical and thermal capabilities of the Sandia Laboratories hybrid microcircuit technology. This evaluation indicated that the present hybrid technology will survive extreme mechanical and thermal environmental conditions, except for long term aging of soldered components which have a significant detrimental effect on solder joint strength. (auth)

5472 (SAND—75-0616) Filament formation on printed wiring boards. Jennings, C.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1975. Contract AT(29-1)-789. 34p. Dep. NTIS $4.00.

Available information on filaments grown as whiskers and by electromigration on printed wiring boards is reviewed and means for preventing or minimizing their effect are listed. New data is presented on filaments grown by electromigration under condensing moisture conditions. Early studies showed silver migration to be a problem when electrical systems were operated with silver conductors in high humidity environments. It has been demonstrated that typical printed wiring board conductors (without silver) can develop filaments in minutes with dc potentials as low as 3 volts when there is a visually observable moisture path between the conductors. Leakage resistances from such filaments have been found to be several decades lower than those normally observed for boards in high relative humidities without bulk moisture. Ionic residues aid but are not necessary for filament growth. Coatings are helpful in preventing filament formation but they cannot offer complete protection unless they are free from pinholes, scratches and other defects. Enclosing boards or electronic assemblies in plastic bags has been effective in preventing filament formation during thermal cycling. (auth)

5473 (SAND—75-6063) Distributed parameter sensitivity: O'Shea, Wyndrum and a new DP synthesis method. Linn, J.K.; Karni, S. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 10p. (CONF-751053—1). Dep. NTIS $4.50.

From The allerton conference; Urbana, Illinois, USA (1 Oct 1975).

Synthesis forms affect some sensitivity measures in Uniform RC Distributed Networks. Wyndrum and O'Shea synthesis methods for URC distributed networks are compared from a sensitivity standpoint. A new decomposition form for synthesis is shown to result in a network with reduced parameter sensitivity. 6 figures. (auth)

5474 (SAND—75-7081) Fabrication of a ferroelectric gate memory transistor. Park, J.K.; Grannenmann, W.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 7p. (CONF-751206—3). Dep. NTIS $4.50.

From IEEE international electron devices meeting; Washington, District of Columbia, USA (1 Dec 1975).

Transistors were fabricated using a sputtered barium titanate dielectric for the gate insulator. The insulator shows two polarization states. It is possible to have normal field effect transistor characteristics in one state and the transistor turned off in the other state. These transistors may be useful in memory applications. (auth)

5475 (UCRL—77449) **Nanosecond switching of high power laser activated silicon switches.** Zucker, O.S.; Long, J.R.; Smith, V.L.; Page, D.J.; Roberts, J.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1975. Contract W-7405-Eng-48. 23p. (CONF-751108—13). Dep. NTIS $4.50.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

Light activated multilayered silicon semiconductor devices have been used to switch at MW power levels with ns turnon time. Current rate of rise of 700 kA/ns at 10 kA, with 1 kV across the load have been achieved. (auth)

5476 (UCRL—77454) **Be objective: evaluate the technology for repairing printed boards and printed board assemblies.** Hersey, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1975. Contract W-7405-Eng-48. 51p. (CONF-751139—1). Dep. NTIS $5.50.

From Electrical;electronics insulation conference; Boston, Massachusetts, USA (11 Nov 1975).

The technology of repairing printed boards and printed board assemblies is discussed in terms of guidelines for making, testing, evaluating, and accepting repairs; the economics of repair; and recommended electrical, mechanical, and environmental tests for ensuring that the repaired printed boards and printed board assemblies meet all design requirements. (LCL)

5477 **Active-R filter.** (to U.S. Energy Research and Development Administration). US Patent Application 541,177. Filed date 15 Jan 1975. 11p.

This invention describes an operational amplifier-type filter in which the only capacitor in the circuit is the compensating capacitance of the operational amplifiers, the various feedback and coupling elements solely resistive. (auth)

5478 (ORNL-tr—4060) **Equipment for area monitoring: construction, mode of operation, use.** Blasche, W. Translated by R.G. Mansfield from *Elektronik (Munich)*; **23**: No. 5, 157-160(May 1974). 12p. Dep. NTIS $4.50.

The increase in crime may be combated through technology only by intensified use of protective devices. In particular, the technology of area monitoring equipment has reached a high stage of development using electronics. Nevertheless, little is known about it, even in engineering circles. It is not done with light barriers, window and door contacts, radar devices, or pickup microphones alone. Ingenious combinations of these must be used; i.e., they must be integrated into a system and their data or signals, evaluated centrally. At the same time, they must definitely be able to prevent the great inconvenience of a false alarm. An introduction to these problems and to methods of solution currently available is given. 9 figures, 1 table. (auth)

5479 **Magnetic insulation and microwave generation.** Ott, E.; Lovelace, R.V. (Cornell Univ., Ithaca, NY). *Appl. Phys. Lett.*; **27**: No. 7, 378-380(1 Oct 1975).

A relativistic self-consistent equilibrium is found for the magnetic insulation of a diode for conditions where the voltage rise time is long compared to the cyclotron period. Instability of the magnetic insulation equilibrium may alloy high-power pulsed microwave generation in magnetronlike configurations. (auth)

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

5480 (ANL-EC—73) **General purpose 1 GeV/c separated beam at the Argonne ZGS.** Colton, E. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 40p. Dep. NTIS $5.00.

Design and operation of the low-momentum beam are discussed. In the normal operating mode, the beam acceptance is calculated to be 21 msr percent $\Delta P/P$ at 1 GeV/c. At 0.8 GeV/c, enriched kaon fluxes of 2940 K^- or 16,390 K^+ are expected for 10^{11} 12.3 GeV/c incident protons, while 420 anti p are expected at 1 GeV/c. In the reversed-polarity operating mode, the maximum beam acceptance is calculated to be 15.2 msr percent $\Delta P/P$; excellent momentum resolution is available in pion and proton beams which are run in this mode. Results indicate that the beam operates as predicted, with the exception of separator rejection factors. (auth)

5481 (BNL—20480) **Preliminary design and cost estimate for a 600 MeV, 20 microampere proton synchrotron.** Blewett, J.P.; Chasman, R.; Cottingham, J.G.; Grand, P.; Green, G.K.; Lasky, C. (Brookhaven National Lab., Upton, N.Y. (USA)). 3 Sep 1975. 24p. Dep. NTIS $4.50.

A design study is presented for a 600 MeV proton synchrotron to yield an average current of 20 microamperes. Its purpose is production of negative pions for use in cancer therapy. The machine consists of a 4 MeV electrostatic preinjector, a 20 MeV linac injector, and a magnet ring about 20 meters in diameter. (auth)

5482 (CONF-751115—1) **Fermilab target areas and target train systems.** Lindberg, J.; Grimson, J.; Simon, J.; Theriot, D. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Jul 1975. 26p. Dep. NTIS $4.50.

From 23. conference on remote systems technology; San Francisco, California, USA (16 Nov 1975).

Proton beam-line equipment and shielding in the 400 GeV accelerator external target areas will become radioactive. Target handling systems, similar to trains, were designed and built to transport the radioactive equipment from the target areas to a central target service building for maintenance and repair. These radioactive tasks are carried out using servo manipulators. (auth)

5483 (COO—1805-2) **Acquisition of the ANL 4-MeV electrostatic accelerator. Progress report, September 1, 1974—August 31, 1975.** Dixon, D.R.; Hill, M.W. (Brigham Young Univ., Provo, Utah (USA)). 1975. Contract AT(11-1)-1805. 9p. Dep. NTIS $4.50.

The operation of the ANL 4-MeV accelerator for the reporting period September 1, 1974 through August 31, 1975 is described. Some improvements and modifications to the accelerator and associated equipment are reported, and activities on the three research projects are summarized. An outline of work for the next reporting period indicates a shift from the BYU 2-MeV accelerator to the 4-MeV accelerator to take advantage of the higher beam energy. (auth)

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

5484 (BNL—20325) **Fields and forces for rectangular beams in an AGS.** Herrera, J.C. (Brookhaven National Lab., Upton, N.Y. (USA)). 26 Jun 1975. 19p. Dep. NTIS $4.50.

The direct space-charge fields and forces that are present in a proton beam which has a rectangular cross section and a uniform charge density are considered. The horizontal and vertical betatron tune shifts, corresponding to these forces, which occur within such a beam are calculated. In addition, a direct extension of this rectangular model produces analytical expressions for the tune changes characteristic of a beam profile which has symmetrical or unsymmetrical linear variations of charge density at the horizontal edges of the beam. (auth)

5485 (JINR—P9-9120) **Increasing intensity of the beam accelerated in JINR synchrophasotron. II. Resonance losses, comparison of experiment and theory. Further perspectives.** Beznogikh, Yu.D.; Bonch-Osmolovskii, A.G.; Voevodin, M.A.; Zinov'ev, L.P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 24p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

Resonances due to the dynamic Coulomb displacement of the oscillation frequency and responsible for particle loss in the synchrophasotron were determined. The widths and strengths of these resonances were evaluated, and a comparison was made between theory and experiments. Future development trends to increase the beam intensity of the accelerator are indicated. (tr-auth)

5486 (JINR—P11-9107) **Investigation of the solution of systems of nonlinear differential equations with periodic coefficients in the vicinity of the resonance $2\nu_x - \nu_x = 1$ by the averaging method.** Amirkhanov, I.V.; Vasilev, V.K.; Zhdkov, E.P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 12p. (In Russian). Dep. NTIS (US Sales Only) $4.50.

Systems of non-linear differential equations with periodic coefficients in the vicinity of the resonance $2\nu_z - \nu_x = 1$ were investigated. Shortened equations were found by the averaging method. These equations were investigated. (tr-auth)

5487 (LA—6043-MS) **Calculated neutron spectrum from 800-MeV protons incident on a copper beam stop.** Perry, D.G. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-ENG-36. 14p. Dep. NTIS $4.00.

A Monte Carlo calculation was performed to obtain the neutron spectrum generated by 800-MeV protons incident on the LAMPF main copper beam stop. The total flux is calculated to be of the order of 10^{13} n/cm^2-sec-mA at full-beam intensity of 1 mA, with flux spectra calculated for angles of 20°, 30°, 60°, 90°, 120°, and 150°. (auth)

5488 (SAND—75-5746) **Ionization front accelerator.** Olson, C.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 29p. (CONF-751108—8). Dep. NTIS $4.50.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

In a recently proposed linear collective accelerator, ions are accelerated in a steep, moving potential well created at the head of an intense relativistic electron beam. The steepness of the potential well and its motion are controlled by the external ionization of a suitable background gas. Calculations concerning optimum choices for the background gas and the ionization method are presented; a two-step photoionization process employing Cs vapor is proposed. In this process, a super-radiant light source is used to excite the gas, and a UV laser is used to photoionize the excited state. The appropriate line widths and coupled ionization growth rate equations are discussed. Parameter estimates are given for a feasibility experiment, for a 1 GeV proton accelerator, and for a heavy ion accelerator (50 MeV/nucleon uranium). (auth)

5489 (LA-tr—75-32) **Mutual transformation of longitudinal and transverse emittances of accelerated beams.** Murin, B.P.; Gromov, E.V.; Kushin, V.V. Translated from *Tr. Radiotekh. Inst.*; No. 16, 348-360(1974). 8p. Dep. NTIS $4.50.

An accelerated beam transformation permitting a reduction of either its longitudinal or transverse beam emittance was studied. The main requirement for the emittance reduction is the existence of short, well-focused bunches in the beam prior to transformation. The better the beam is focused, the higher is the degree of longitudinal emittance reduction; the better the particles are bunched in phase, the higher is the degree of transverse emittance reduction. As the hypervolume occupied by all the points representing the bunch in the six-dimensional space remains unchanged, each of the transformations under consideration is accompanied by an increase in the proections of this hypervolume onto the remaining phase space planes. (auth)

5490 **Mechanical analog of the synchrotron, illustrating phase stability and two-dimensional focusing.** Alvarez, L.W. (Univ. of Califonria, Berkeley); Smits, R.; Senecal, G. *Am. J. Phys.*; **43**: No. 1, 293-296(Jan 1975).

A steel ball bounces in synchronism with a vertically oscillating piston. The piston surface is a hardened steel disk on which the ball bounces; two-dimensional horizontal focusing is provided by the concavity of the surface. The period of oscillation can be varied over a 3:1 range with the amplitude kept constant. As the period is increased, the ball bounces higher. As the period is decreased, the ball bounces lower, contrary to the intuition of most observers. The model illustrates the important properties of synchrotron accelerators. (3 figures) (auth)

AUXILIARIES AND COMPONENTS

5491 (BNL—20605) **Conductor fabrication for ISABELLE dipole magnets.** McInturff, A.D. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 4p. (CONF-750950—3). Dep. NTIS $4.50.

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

Fabrication techniques and specifications are discussed for the composite superconductor braids to be used in the dipole magnets of the ISABELLE Storage Rings. Properties of the NbTi and Cu composite superconductor are given, the braid parameters are presented, and the fabrication processes are shown in photographs. (PMA)

5492 **Test of heavy-ion gas-foil stripping for improved foil lifetime in Tandem Van de Graaff accelerators.** Thieberger, P.; Wegner, H.E. (Brookhaven National Lab., Upton, N.Y. (USA)). *Nucl. Instrum. Methods*; **126**: No. 2, 231-233(1 Jun 1975).

5493 **Operational 40 kG superconducting beam transport magnet and its cryogenic system.** Allinger, J.; Bamberger, J.; Danby, G.; DeVito, B.; DiLullo, C.; Foelsche, H.; Gibbs, R.; Hsieh, S.; Jackson, J.; Prodell, A. (Brookhaven National Lab., Upton, NY). *J. Eng. Ind.*; **97**: No. 3, 921-924(Aug 1975).

From American Society of Mechanical Engineers winter annual meeting; New York, NY, USA (17 Sep 1974).

A superconducting 40 kG magnet system 4 meters long is now operating which bends the 30 billion electron volt primary proton beam produced by the Brookhaven Alternating Gradient Synchrotron. The magnet design is unique in that commercially available niobium titanium composite superconductor and relatively high purity aluminum are used in combination with low carbon steel magnet cores to provide excellent magnetic and thermal stabilization. This magnet system is operating on line in a closed loop, zero loss helium refrigeration system. Details of the magnet structure, dewars, and cryogenic system will be discussed. (auth)

ION SOURCES

5494 (CONF-751048—3) **Lifetimes of carbon stripping foils.** Yntema, J.L. (Argonne National Lab., Ill. (USA)). Oct 1975. Contract W-31-109-Eng-38. 5p. Dep. NTIS $4.50.

From International conference on heavy ion sources; Gatlinburg, Tennessee, USA (27 Oct 1975).

In an effort to produce a coherent picture of foil lifetimes, a review is given of results of various authors on the use of carbon foil beam strippers for heavy ion facilities. Foil heating in the tandem terminal during heavy ion bombardment, combined with oscillation of the foil, should produce acceptable foil lifetimes and improve the beam quality by reduction of the foil thickening effect and the accompanying inhomogeneity. The installation and operation of such a system does not present insurmountable problems. (PMA)

EXPERIMENTAL FACILITIES AND EQUIPMENT

5495 (CONF-751116—4) **Auxiliary/Master microprocessor CAMAC Crate Controller applications.** Barsotti, E. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). 1975. 4p. Dep. NTIS $4.50.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

The need for further sophistication of an already complex serial CAMAC control system at Fermilab led to the development of an Auxilary/Master CAMAC Crate Controller. The controller contains a Motorola 6800 microprocessor, 2K bytes of RAM, and 8K bytes of PROM memory. Bussed dataway lines are time shared with CAMAC signals to provide memory expansion and direct addressing of peripheral devices without the need of external cabling. The Auxiliary/Master Crate Controller (A/MCC) can function as either a Master, i.e., stand alone, crate controller or as an Auxiliary controller to Fermilab's Serial Crate Controller (SCC). Two modules, one single- and one double-width, make up an A/MCC. The microprocessor has one nonmaskable and one maskable vectored interrupt. Time sharing the dataway between SCC programmed and block transfer generated dataway cycles and A/MCC operations still allows a 99 percent microprocessor CPU busy time. Since the conception of the A/MCC, there has been an increasing number of control system-related projects proposed which would not have been possible or would have been very difficult to implement without such a device. The first such application now in use at Fermilab is a stand-alone control system for a mass spectrometer experiment in the Main Ring Internal Target Area. This application in addition to other proposed A/MCC applications, both stand-alone and auxiliary, is discussed. (auth)

STORAGE RINGS

5496 (BNL—20565) **ISABELLE full scale dipoles.** McInturff, A.D.; Dahl, P.F.; Kassner, D.; Lasky, C.; Robins, K.; Sampson, W.B. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 5p. (CONF-750950—4). Dep. NTIS $4.50.

From Conference on technical applications of superconductivity; Alushta, USSR (16 Sep 1975).

Data are presented on the various cosine theta type magnet models constructed at BNL in the development of ring magnets for ISABELLE, a pair of intersecting 200 GeV proton accelerating storage rings. The rings are to be filled with 30 GeV protons from the AGS and then accelerated to 200 GeV. The acceleration period is a 120 sec ramp from approximately 0.5 T to 4 T. The effect of mechanical precompression on training was studied by varying the interference fit between the coil (ISA IV) and its iron shield. The results were used to optimize the mechanical design of the full-size magnet models. (auth)

5497 (BNL—20584) **Reexamination of the ISABELLE box car stacking scheme.** Chasman, R. (Brookhaven National Lab., Upton, N.Y. (USA)). 26 Aug 1975. 12p. Dep. NTIS $4.50.

Box car stacking of ISABELLE after acceleration of the fundamental frequency in the AGS is reviewed with the present ISABELLE parameters and examined with regard to longitudinal impedence requirements. The scheme results in an impedance tolerance of Z/n less than or equal to 30 Ω compared to Z/n less than or equal to 5 Ω obtained for rf stacking. However, to meet the claimed luminosity, the AGS performance demands are increased above those assumed in the ISABELLE proposal. (auth)

5498 (BNL—20609) **Ring insertions as light sources.** Green, G.K. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 12p. (CONF-751067—1). Dep. NTIS $4.50.

From Madison users meeting; Stoughton, Wisconsin, USA (20 Oct 1975).

Bending magnets can be inserted in the long straight sections of electron storage rings to produce synchrotron radiation. If the design is carefully proportioned, the bending magnets create only a small perturbation of the properties of the ring. The resulting spectra have favorable optical properties as sources for spectroscopy and diffraction studies. The characteristics of the source are discussed, and the geometrical requirements of the magnets are presented. (PMA)

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

5499 (BNL—20366) **Triple-coincidence with automatic chance coincidence correction.** Chase, R.L. (Brookhaven National Lab., Upton, N.Y. (USA)). May 1975. 12p. (CONF-751116—2). Dep. NTIS $4.00.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

The chance coincidences in a triple-coincidence circuit are of two types—partially correlated and entirely uncorrelated. Their relative importance depends on source strength and source and detector geometry so that the total chance correction cannot, in general, be calculated. The system described makes use of several delays and straightforward integrated circuit logic to provide independent evaluation of the two components of the chance coincidence rate. (auth)

5500 (BNWL-CC—1834) **Burst reactor tests of a neutron sensitive criticality detector.** Friend, P.C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 30 Sep 1968. 8p. Dep. NTIS $4.50.

The Pacific Northwest Laboratory in Richland, Washington, operated by Battelle Memorial Institute for the Atomic Energy Commission has a new alarm system to detect and warn of uncontrolled nuclear criticality accidents. The basic elements of the system, neutron sensitive criticality detectors were tested at pulsed reactor sites. Results are presented. (WHK)

5501 (CONF-750482—2) **Remote acquisition of gamma-ray pulse height spectra.** Killian, E.W.; Heath, R.L. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. 4p. Dep. NTIS $4.00.

From DECUS symposium; Miami, Florida, USA (15 Apr 1975).

The acquisition of pulse height spectra data in the industrial environment has traditionally evolved along two paths. The first required the transporting of a radioactive sample from the place of production to a computer system for counting and analysis. This method results in a degradation of the data due to the time delay between sample production and subsequent counting. The second path was taken to count the sample at the place of production and transport the data in the form of paper or magnetic tape to a computer for analysis. Automation of the traditional methods is usually impractical. This paper describes two methods of remote data acquistion developed at the Idaho National Engineering Laboratory which were formulated to mechanize the complete process from data gathering to analysis. Both methods utilize voice grade telephone links between the data gathering device and a PDP-9 computer. The two methods differ in the type of device used to acquire the data. The first is a completely hardwired system. The second is a computer based system utilizing a PDP-8/E. Differences between the two systems are described and evaluations made as to cost versus versatility. (auth)

5502 (CONF-751116—6) **Rejection of radio-frequency noise with a wide-band differential preamplifier and solid-shielded coaxial input cables.** Burns, R.S.; De Lorenzo, J.T. (Oak Ridge National Lab., Tenn. (USA)). 1975. 17p. Dep. NTIS $4.50.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

Radio-frequency signals simulating electrical interference ranging from 50 Hz to 50 MHz were applied to the shields of the input cable system (two solid-shielded, mineral-insulated cables approximately 6 m long) of a wide-band (approximately 60 MHz) differential preamplifier for use with fission counters as input devices as part of in-vessel, low-level flux monitors in future liquid-metal fast breeder reactors (LMFBRs) to determine the common-mode rejection. Results show that differences in electrical properties and shielding characteristics of the two input coaxial cables along with end effects produced by an unbalanced sensor severely degrade the rejection capability of the differential preamplifier. At 1 MHz, the common-mode rejection without input cables is approximately -70 dB; this is reduced to approximately -10 dB when measured with the rf signal applied to the surface of the input cable shields. Measurements of the shielding characteristics of the input cables showed resonances at test frequencies greater than 2 MHz. A ferrite core was installed in the input assembly to increase the impedance of the shields and to permit termination of the coaxial line consisting of the input cable shields and the protective metal conduit for the input cables. This assembly eliminated all resonances below 20 MHz. The increased impedance also reduced the amplitude of the shield currents, resulting in an increase in the shielding effectiveness of the input cables without affecting the signal transmission of the cables. (auth)

5503 (CONF-751116—7) **Design of optimized RC-CR filters for current-pulse operation of fission counters and high sensitivity fission counters for high gamma backgrounds.** DeLorenzo, J.T. (Oak Ridge National Lab., Tenn. (USA)). 1975. 36p. Dep. NTIS $5.00.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

A calculational procedure was developed to design RC-CR filters for processing current pulses from fission counters in a gamma background ranging from 10^5 to 6 x 10^8 R/hr. The effects of noise from the gamma background and the input preamplifier and of the time constant of the fission counter and input cable were studied. Analytical results were in close agreement with experimental data. A pole-zero network was examined as a means of compensating for the time constant of the fission counter and input cable, but its improvement was insignificant. The procedure was expanded to design a high sensitivity, gamma-tolerant fission counter (approximately 10 counts sec^{-1} NV^{-1} at 10^5 R/hr), and the result was a conceptual design with a performance almost equal to a recently developed high temperature fission counter. (auth)

5504 (EGG—1183-1635) **Calibration of XRDs for photon energies below one kilovolt.** Singman, L. (EG and G, Inc., Las Vegas, Nev. (USA)). 10 Jun 1974. 18p. Dep. NTIS $4.00.

Several windowless XRD x-ray detectors have been calibrated at x-ray photon energies below 1 keV. Three spectral lines were used in the calibration: Ckα (279 eV), FeLα (705 eV) and CuLα (926 eV). The lines were generated by a Henke x-ray tube utilizing the characteristic radiation of the appropriate anode material. About 95 percent spectral purity was achieved by a combination of x-ray tube operation at the lowest possible voltage and by filtering. The intensities were measured with an ionization chamber filled with argon at pressures of 50 and 100 mm Hg. The windows for the x-ray tube and ionization chamber consisted of aluminized polycarbonate film. The resulting detector sensitivities approximately fitted the absorption curve for gold. (auth)

5505 (EGG—1183-2319) **Nuclear radiation measurement using Cerenkov light generated in a light guide.** Doyle, J.E.; Nelson, M.A.; Davies, T.J.; Franks, L.A. (EG and G, Inc., Goleta, Calif. (USA)). Jun 1975. 9p. (CONF-751101—27). Dep. NTIS $4.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Measurement of the Cherenkov response of a low-loss fiber optic light guide has established the feasibility of a simple nuclear diagnostic measurement technique wherein a small section of the guide is irradiated by charged particles to generate a radiation-proportional optical signal. The measurements described appear to show useful sensitivity, wide bandwidth, and other advantages associated with use of a light guide simultaneously as a radiation converter and optical signal transmission link. Typical observed sensitivity is 5.5 x 10^3 photons per nanosecond at 570 nm for an incident relativistic electron flux of 4 A per cm^2 in a 50-ps pulse. Time resolution for a 500-m multimode graded index fiber was 1.6 ns using a 5-nm-wide optical filter. (auth)

5506 (EGG—1183-2329) **Capabilities of mercuric iodide as a room temperature x-ray detector.** Slapa, M.; Huth, G.C.; Seibt, W.; Tove, P.A.; Schieber, M.M.; Randtke, P.T. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology; Uppsala Univ. (Sweden); EG and G, Inc., Goleta, Calif. (USA)). Oct 1975. 9p. (CONF-751146—1). Dep. NTIS $4.50.

From Conference of the IEEE; San Francisco, California, USA (20 Nov 1975).

Measurement results obtained with HgI_2 detectors at room temperature in the low energy x-ray region down to 2 keV are reported. The best resolution obtained is 548 eV for 5.9 keV x-rays, and the 2.01 keV phosphorous x-ray line has been resolved with a detector with an area of 14 mm^2. The optimization of the detector-amplifier system and polarization effects in the detectors are discussed. (auth)

5507 (ORNL-tr—4035) **Measuement of multiplicity of fission neutrons using a large-volume scintillator containing gadolinium.** Ribrag, M.; Poitou, J.; Matuszek, J.; Signarbieux, C. Translated by M. Gerrard from *Rev. Phys. Appl.*; 7: No. 3, 197-203(1972). 14p. Dep. NTIS $4.50.

A large liquid scintillator filled with gadolinium and used at Saclay for fission neutron-multiplicity experiments is described. An original procedure for optimal adjustments of the detecting system and its associated electronics so as to minimize possible systematic errors is also presented. Several errors and their associated corrections are treated in detail. Results for spontaneous fission of ^{252}Cf are compared with the data published by others. (auth)

5508 **Use of high-purity germanium detectors for intermediate-energy physics experiments.** Amann, J.F.; Barnes, P.D.; Dytman, S.A.; Penkrot, J.A.; Thompson, A.C. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)); Pehl, R.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nucl. Instrum. Methods;* 126: No. 2, 193-198(1 Jun 1975).

RADIATION DOSEMETERS

5509 **Quo vadis, personnel monitoring.** Becker, K. (Oak Ridge National Lab., TN). *Nucl. Saf.*; 16: No. 6, 728-733(1975).

With the increasing use of nuclear power and radiation sources, the selection of optimum systems for personnel monitoring is becoming a matter of worldwide concern. The present status of personnel dosimetry, sometimes characterized by unstable and inaccurate detectors and oversimplified interpretation of the results, leaves much to be desired. In particular, photographic film, although having certain advantages with regard to economics and information content, undergoes rapid changes in warm and humid climates. Careful sealing reduces, but does not prevent, these problems. The replacement of film by solid-state dosimeters, primarily thermoluminescence dosimeters, is in progress or being considered by an increasing number of institutions and requires a number of decisions concerning the choice of the optimum detector(s), badge design, and evaluation system; organizational matters, such as the desirability of automation and computerized bookkeeping; etc. The change also implies the potential use of such advanced concepts as different detectors and monitoring periods for the large number of low-risk persons and the small number of high-risk radiation workers. (auth)

5510 **Low-dose measurements with the Victoreen 2800 TLD system.** Benko, L. (Magyar Tudomanyos Akademia Izotop Intezete, Budapest). *Health Phys.*; 29: No. 5, 787(Nov 1975).

Investigations directed towards reducing the low-dose limit of a Victoreen 2800 TLD system are reported. The effect of reading the dosimeters in nitrogen atmosphere at a flow rate of 0.6 l/min, elimination of the friction and, as far as possible, the contact of the dosimeters with surrounding materials, elimination of light excitation, high-precision and frequent control of the photomultiplier tube dark current zero adjustment are reported. (UK)

HIGH ENERGY PHYSICS INSTRUMENTATION

5511 (CONF-751116—1) **Two-phase fluid density measurement with a two-beam radiation densitometer.** Lassahn, G.D. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 6p.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

A densitometer consisting of two beams of radiation passing through a pipe is very useful for measuring the average density and the density distribution of inhomogeneous two-phase fluids in the pipe. The general technique is illustrated by an example. (auth)

5512 (FSU-HEP—75-6-5) **Ionization identification of charged particles in bubble chamber experiments.** Rauchwarger, K.A. (Florida State Univ., Tallahassee (USA)). Jun 1975. 42p. Dep. NTIS $5.00.

Thesis.

A computer program has been developed which identifies charged particles from bubble chamber photographs by comparing the pulse height information from an automatic measuring device (The Spiral Reader) to an expected ionization of various mass charged particles. Of all identifiable tracks made by charged particles of momentum below 1500 MeV/c, 70 percent were identified correctly, 28 percent could not be identified and 2 percent were incorrectly identified. Since a kinematical analysis takes precedence over ionization identification, only 16 percent of all events needed to be sent to human operators for identification. The identification programs in misidentification of 2 percent of all identifiable tracks correspond to less than 1 percent of all events being incorrectly identified. (auth)

5513 (ORNL-TM—5118) **Calculated performance of a segmented pyramid-shaped calorimeter of iron and plastic.** Amburgey, J.D.; Gabriel, T.A. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 25p. Dep. NTIS $4.00.

The calculated performance of a segmented pyramid-shaped calorimeter of iron and plastic is presented. The types of incident particles considered are protons, charged pions, and electrons. The momentum range is 0.2 to 8 GeV/c. The calculated resolution ($\Delta E/E$) obtained for protons and charged pions decreases from approximately 90 percent at 1 GeV to approximately 50 percent at 8 GeV. For incident electrons, the resolution decreases from approximately 25 percent at 1 GeV to approximately 8 percent at 8 GeV. (auth)

RADIOMETRIC INSTRUMENTS

5514 (LBL—4248) **Energy dispersive x-ray fluorescence spectrometry using pulsed x-ray excitation.** Jaklevic, J.M.; Landis, D.A.; Goulding, F.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 14p. (CONF-750831—2). Dep. NTIS $4.00.

From 24. annual conference on applications of x-ray analysis; Denver, Colorado, USA (6 Aug 1975).

5515 **100-mg ^{252}Cf activation analysis facility at SRL.** MacMurdo, K.W.; Bowman, W.W. (E.I. du Pont de Nemours and Co., Aiken, SC). *Trans. Am. Nucl. Soc., Suppl.;* 21: No. 3, 28-29(1975).

From International nuclear and atomic activation analysis conference and 19. annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

5516 **Data reduction in the ^{252}Cf activation analysis facility at SRL.** Bowman, W.W.; MacMurdo, K.W. (E.I. du Pont de Nemours and Co., Aiken, SC). *Trans. Am. Nucl. Soc., Suppl.;* 21: No. 3, 29(1975).

From International nuclear and atomic activation analysis conference and 19. annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

5517 (PEM—37) **Some handbook references and a summary for "EMP engineering and design principles".** Martin, L.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1975. 6p. Dep. NTIS $4.50.

The material in this note contains a number of handbook-oriented references and also constitutes a brief review and summary for the copyrighted publication "EMP Engineering and Design Principles," a book by the Electrical Protection Department, Loop Transmission Division, Bell Telephone Laboratories, Incorporated, Whippany, New Jersey; copyrighted 1975. (WHK)

5518 (PEM—40) **Interface circuit protection in satellite applications.** Sheppard, T.J. . (TRW Systems Group, Redondo Beach, Calif. (USA)). Jul 1975. 24p. Dep. NTIS $4.50.

EMP and radiation-induced electrical transients generated on the interconnect cables can cause severe damage or burnout of sensitive active components. Protection of interface circuitry in weight critical systems such as satellites can best be achieved by the addition of discrete voltage clamps, current limiters or filters. Design engineers, aware of these techniques, can include this type of protection in initial circuit designs and consequently eliminate any redesign for hardness. (auth)

MISCELLANEOUS INSTRUMENTS

5519 (CEA-CONF—3018) **Instrumentation intended for the calibration of calorimeters.** Pierre, J. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Transfert et Conversion d'Energie). 1974. 6p. (In French). INIS.

From Annual meeting on calorimetry and thermal analysis; Rennes, France (9 May 1974).

A device is presented allowing the calibration of various types of calorimeters by the Joule effect. (FR)

5520 (DP—1379) **Analog signal recorder.** Sand, R.J. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Oct 1975. Contract AT(07-2)-1. 11p. Dep. NTIS $4.00.

An analog signal recorder was designed and built by interfacing an audio cassette tape recorder with input frequency modulators for converting the signal for tape storage and with output frequency demodulators that reconstruct the signal for data sampling. The system is inexpensive, portable, and versatile. Full-scale input ranges are 0 to 50 mV, 0 to 100 mV, 0 to 1 V, or 0 to 10 V; output is 0 to +- 10 V. Frequency response is between 0 and 10 Hz. (auth)

5521 (GERHTR—117) **Influence of the method of measurment on the optical anisotropy factor OPTAF of pyrocarbon.** Koizlik, K.; Taeuber, K.; Nicke. H.; Wasmund, H. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jul 1974. 35p. Dep. NTIS $5.00.

Work Performed under United States—German High Temperature Reactor Research Exchange Program.

This study describes the development and installation of an automatic microscope photometer for the measurement of the optical anisotropy factor OPTAF on the pyrocarbon coatings of fuel particles. After a short representation of the physical basis of this procedure the new microscope photometer is introduced. First measurements for the adaptation of the new instrument of the so far used microscope photometer are discussed. By these measurements the influence of the instrument on the value of OPTAF in the case of some special ways of measuring are explained and the appearance of an apparent anisotropy is interpreted. (auth)

5522 (LA—6057-PR) **Development of air-sampling techniques. LASL Project R-059, NIOSH-IA-74-10. Progress report, October 1, 1974—March 31, 1975.** Campbell, E.E.; Wood, G.O.; Anderson, R.G. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. Contract W-7405-eng-36. 18p. Dep. NTIS $4.00.

A silica gel tube for sampling aliphatic amines in air has been proposed based on experimental studies. Sampling methods and analytical procedures using this tube also are described. Total retention on the tube during sampling of methylamine, ethylamine, dimethylamine, isopropylamine, butylamine, diethylamine, triethylamine, and diisopropylamine can be achieved even at extreme concentration and humidity conditions. Complete removal from silica gel for analysis has been demonstrated for all but the latter two amines, for which desorption by sulfuric acid can be made greater than 80 percent. Sensitivity of the proposed gas chromatographic analytical method also has been measured. An air sampling and analysis method for hydrazine, methylhydrazine, and 1,1-dimethylhydrazine has been developed. A sampling tube containing sulfuric acid-coated silica gel is proposed. Complete retention of hydrazines on this sorbent during sampling and complete elution by distilled water has been demonstrated. (auth)

5523 (LBL—3930) **Present status of automatic ellipsometers.** Muller, R.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-ENG-48. 33p. (CONF-750993—2). Dep. NTIS $5.00.

From 3. international conference on ellipsometry; Lincoln, Nebraska, USA (23 Sep 1975).

Operating principles and capabilities of presently-built automatic ellipsometers are reviewed. The instruments are classified according to their optical principles of operation and their capabilities are compared on the basis of uniform performance criteria. Possible future developments are indicated. (auth)

5524 (LBL—4219) **Optical timing receiver for the NASA laser ranging system. Part I. Constant-fraction discriminator.** Leskovar, B.; Lo, C.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 14 Aug 1975. Contract W-7405-Eng-48. 25p. Dep. NTIS $4.00.

Position-resolution capabilities of the NASA laser ranging system are essentially determined by time-resolution capabilities of its optical timing receiver. The optical timing receiver consists of a fast photoelectric device, primarily a standard of microchannel-plate-type photomultiplier or an avalanche photodiode detector, a timing discriminator, a high-precision time-interval digitizer, and a signal-processing system. The time-resolution capabilities of the receiver are determined by the photoelectron time spread of the photoelectric device, the time walk and resolution characteristics of the timing discriminator, and the time-interval digitizer. It is thus necessary to evaluate available fast photoelectronic devices with respect to their time-resolution capabilities, and to design a very low time walk timing discriminator and a high-precision time digitizer which will be used in the laser ranging system receiver. (auth)

5525 (SAND—75-0116) **Simplified calibration sequence for single-atom mass spectrometers.** Panitz, J.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 16p. Dep. NTIS $4.00.

A calibration procedure is described for single-atom, time-of-flight mass spectrometers which essentially applies a least-squares analysis to the measured parameters of voltage, distance and time in order to calculate the actual potential at the specimen surface, and any time delay associated with the measurements. A computer program numerically solves the required simultaneous equations by a variation of the Newton-Raphson method, quickly predicting the unknown desorption pulse amplitude and time delay to an accuracy of one part in 10^5. (auth)

5526 (SAND—75-5462) **Application of multibeam laser velocimetry to gas flow measurements.** Hackett, C.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 22p. (CONF-751072—1). Dep. NTIS $4.50.

From Laser anemonetry symposium; Minneapolis, Minnesota, USA (22 Oct 1975).

The theory and design considerations for both real and virtual multibeam laser velocimetry systems have been developed for application to gas flow measurements inside a chemical laser device. The advantages of multibeam laser velocimetry are discussed in comparison with existing systems. The design features of a spatially scanning virtual multibeam wavelength tunable laser velocimeter system for use on an actual chemical laser device are described. The computer interfacing and serial multiplexing schemes for three dimensional velocimetry are discussed. (auth)

5527 (TID—26736) **Sodium ionization leak detector. Monthly progress letter report for January, 1975.** (Westinghouse Electric Corp., Hunt Valley, Md. (USA). Nuclear Instrumentation and Control Dept.). 14 Feb 1975. Contract AT(11-1)-2499. 4p. Dep. NTIS $4.00.

5528 (UCID—16937(Pt.1)) **Automatic radiochemical gas-separation system development. Part I. Overview.** Adams, T.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Oct 1975. Contract W-7405-Eng-48. 12p. Dep. NTIS $4.00.

A working prototype of a fully automatic gas-separation system has been constructed and is now operational in a semiautomatic mode under manual control. In its final form the system is designed to automatically select a sample of appropriate size, perform the desired separations and pertinent calculations, present real-time analytical results, and recover the purified sample constituents. The separations are accomplished by elution chromatography with a computer that controls, commands, and performs analytical calculations. Two laboratory innovations, fully temperature-programmable automatic elution columns and vacuum-actuated pneumatic valves, form the heart of the system. The configuration, design, operating procedure, and status of the system are described. A companion paper, Part 2, contains a detailed description of the individual system components. (auth)

5529 (UCID—16937(Pt.2)) **Automatic radiochemical gas-separation system development. Part 2. System components.** Adams, T.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Oct 1975. Contract W-7405-Eng-48. 23p. Dep. NTIS $4.00.

The automatic gas separation system is designed to automatically select an appropriate size sample, perform the desired separation and pertinent calculations, present real-time analytical results, and recover the purified sample constituents. The separations are accomplished by elution chromatography with a computer for command and control. A functioning semiautomatic prototype has been constructed. A detailed description of each component of the system is given. A general description of the design, operating procedure, and status of the system appeared in Part 1 of this series. (auth)

5530 (UCRL-Trans—10971) **Mirror systems with grazing incidence as image-forming optics for x-rays.** Wolter, H. Translated from *Ann. Phys.* (*Leipzig*); **10**: 94-114(1952). 39p. Dep. NTIS $5.00.

Systems of totally reflecting mirrors may be used as the optics in x-ray microscopy. With elimination of the spherical aberration for an axial point, these systems at the same time satisfy the Abbe sine condition up to apertures of 0.05. To investigate live biological specimens, wavelengths of approximately 24 A are recommended since these are minimally absorbed in water but have a high absorption in materials containing carbon or nitrogen. With the optical system presented in this paper, for such soft x-

rays the increase in resolving power compared to ordinary light microscopes is at least one order of magnitude. 19 figures, 1 table. (auth)

5531 Comments on Manganin wire pressure gauges (research note). Andeen, C.; Schuele, D. (Case Western Reserve Univ., Cleveland). *High Temp. - High Pressures;* 5: 597-598(1973).

A standard Manganin wire pressure gauge has been examined by comparing it with a recently developed 0.01 percent CaF_2 capacative pressure gauge. The effects of the Bridgman "water kick" and intrinsic time constant are clearly shown and the results punctuate the usual assertion that Manganin wire gauges are extremely difficult to use approaching the 0.1 percent level of accuracy. (auth)

5532 Temperature measurement in a high-temperature carbon multilayer reentry vehicle heatshield. Wright, G.F. Jr.; Beard, S.G. Jr.; McVey, D.F. (Sandia Labs., Albuquerque, NM). pp 325-331 of In Advances in thermal conductivity. Reisbig, R.L. (ed.). Rolla, MO; Univ. of Missouri (1974).

From 13. international conference on thermal conductivity; Lake Ozark, Missouri, USA (5 Nov 1973).

See CONF-731106—.

During flight testing of reentry vehicles, heatshield temperature data are required. A thermal sensor for collecting the data is described; it was used to measure temperatures in carbon/carbon heatshields. Measured and computed temperatures are compared. (DLC)

5533 Development of a multipurpose optical system for use with a centrifugal fast analyzer. Burtis, C.A.; Bostick, W.D.; Johnson, W.F. (Oak Ridge National Lab., TN). *Clin. Chem.;* 21: No. 9, 1225-1233(1975).

A Centrifugal Fast Analyzer is basically a sophisticated photometric measuring device containing a multicuvet rotor as its major component. Several reactions are simultaneously initiated in the rotor, which is then rotated through a stationary optical monitor and the resulting signals acquired and processed by an on-line data system. With the miniature version of this analyzer, one has the option of directing the incident optical beam, via a fiber optical bundle, into the cuvets of the spinning rotor in either a 90^0 or a 180^0 orientation relative to the analyzer's photodetector. The combination of newly designed rotors and a flexible optical system having multiple configurations has provided a versatile system in which one can measure the transmittance, fluorescence, chemiluminescence, or light-scattering (either turbidimetrically or nephelometrically) properties of the ensuing reaction species, all with a single analyzer. This flexibility in choosing the optical mode in which a particular set of reactions is to be monitored provides the analyst with a powerful and versatile analytical tool for developing new methods for use in various clinical laboratory applications, including chemistry, toxicology, immunology, and hematology. (auth)

5534 Secondary high pressure standard for the far-infrared spectral region. Smith, B.T.; Sievers, A.J. (Cornell Univ., Ithaca, NY). Contract AT(11-1)-3151. *Rev. Sci. Instrum.;* 46: No. 2, 222-223(Feb 1975).

The infrared-active defect lattice mode in $NaCl:Cu^+$ provides a convenient secondary pressure standard for far-infrared measurements of solids at low temperatures. (auth)

5535 Equipment developed for static high temperature resistivity measurements. Slivinsky, S.H. (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA). *Rev. Sci. Instrum.;* 46: No. 4, 451-455(Apr 1975).

Apparatus has been developed to accurately measure electrical resistivity as a function of temperature at high temperature for metals and alloys. The resistivity of 0.254 mm diam tantalum wire has been measured between the temperatures 1170 and 2860 K. Temperature measurements were taken with an automatic optical pyrometer, a two-color ratio pyrometer, and a tungsten-rhenium thermocouple. The temperature observations were made under simulated blackbody conditions, in accordance with the blackbody calculations of deVos. The 2 to 3 percent agreement with the tantalum data previously published indicates that the apparatus performs satisfactorily. (auth)

5536 Irreversible humidity indicator. Reif, R.B.; Kurz, P.F. (to U.S. Energy Research and Development Administration). US Patent 3,898,172. 5 Aug 1975. Filed date 3 May 1973. 10p.

PAT-APPL-356,863.

This patent relates to a humidity indicator having particles of colored dye distributed over the surface of a dry, deliquescent salt of a neutral color. When exposed to a humidity level above that which causes deliquescence of the salt, the dye bleeds through and imparts its developed tincture to the resulting saturated salt solution. On dehydration, the dye remains infused throughout the dried salt to present an irreversible indication of the humidity exposure. (auth)

5537 Whole blood analysis rotor for a multistation dynamic photometer. Mailen, J.C.; Johnson, W.F. (to U.S. Energy Research and Development Administration). US Patent 3,899,296. 12 Aug 1975. Filed date 17 Jul 1974. 6p.

PAT-APPL-489,305.

A rotor for performing photometric analyses using whole blood samples is described. Following static loading of a gross blood sample in the rotor the red blood cells in the gross sample are centrifugally separated from the plasma and measured subvolumes of plasma distributed to respective sample analysis cuvettes positioned in an annular array about the rotor periphery. Means for adding reagents to the respective cuvettes are also described. (auth)

5538 Whole blood analysis rotor assembly having removable cellular sedimentation bowl. Burtis, C.A.; Johnson, W.F. (to U.S. Energy Research and Development Administration). US Patent 3,901,658. 26 Aug 1975. Filed date 30 Jul 1974. 6p.

PAT-APPL-493,006.

A rotor assembly for performing photometric analyses using whole blood samples is described. Following static loading of a gross blood sample within a centrally located, removable, cell sedimentation bowl, the red blood cells in the gross sample are centrifugally separated from the plasma, the plasm displaced from the sedimentation bowl, and measured subvolumes of plasma distributed to respective sample analysis cuvettes positioned in an annular array about the rotor periphery. Means for adding reagents to the respective cuvettes are also described. (auth)

5539 Phase contrast in high resolution electron microscopy. Rose, H.H. (to U.S. Energy Research and Development Administration). US Patent 3,908,124. 23 Sep 1975. Filed date 1 Jul 1974. 8p.

PAT-APPL-484,740.

This patent relates to a device for developing a phase contrast signal for a scanning transmission electron microscope. The lens system of the microscope is operated in a condition of defocus so that predictable alternate concentric regions of high and low electron density exist in the cone of illumination. Two phase detectors are placed beneath the object inside the cone of illumination, with the first detector having the form of a zone plate, each of its rings covering alternate regions of either higher or lower electron density. The second detector is so configured that it covers the regions of electron density not covered by the first detector. Each detector measures the number of electrons incident thereon and the signal developed by the first detector is subtracted from the signal developed by the record detector to provide a phase contrast signal. (auth)

5540 Device for measuring biaxial strain. Billeter, T.R. (to U.S. Energy Research and Development Administration). US Patent 3,909,713. 30 Sep 1975. Filed date 26 Apr 1974. 8p.

PAT-APPL-464,427.

This patent relates to a device for measuring the biaxial strain of a test specimen utilizing a coaxial resonant cavity, made to resonate in at least two different modes by electromagnetic energy supplied to the cavity. A first mode is dependent upon the diametric dimensions of the cavity. The cavity is formed of a hollow, sensor body whose electrically conductive inner walls, one of which is movable, function as the outer conductor of the coaxial cavity, and which is adapted to receive the test specimen through the movable wall which is rigidly coupled to the test specimen. The outer surface of the test specimen, being electrically conductive, functions as the inner conductor of the coaxial resonator. Dimensional variations in the test specimen result in a variation in the dimensions of the coaxial cavity and therefore in the frequency at which the cavity will resonate in each of the modes. These frequency variations can be monitored to provide a measure of biaxial strain associated with the object. (auth)

5541 Calibration studies of the carbon piezoresistive gauge. Horning, R.R.; Isbell, W.M. (Univ. of California, Livermore). *Rev. Sci. Instrum.;* 46: No. 10, 1374-1379(Oct 1975).

The calibrations, time responses, and Hugoniot for carbon piezoresistive gauges from two manufacturers are presented. These gauges exhibit a high sensitivity of about -20 percent resistance change per GPa at 0.5 GPa. Their equilibration times, when tested in fused silica, exceed 0.6 μsec below 0.5 GPa but improve at higher stresses and under better impedance matching conditions. They can be made of low atomic number materials, making them interesting candidates for studying the mechanical responses of materials to electron and x-ray deposition. (auth)

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

5542 (CONF-740216—) **Proceedings of the 8th symposium on explosives and pyrotechnics, Los Angeles, California, February 5—7, 1974.** (Franklin Inst. Research Labs., Philadelphia, Pa. (USA)). 1974. 397p. Franklin Inst. Research Labs., Philadelphia, PA $4.00.

From 8. symposium on explosives and pyrotechnics; Los Angeles, California, USA (5 Feb 1974).

A separate abstract was prepared for 4 of the 50 papers presented at the conference. The remaining 46 papers were not in scope for ERA. (TFD)

5543 (CONF-740216—, pp 1.1-1.4) **Improved hot-wire electroexplosive devices.** Joppa, R.M. (Los Alamos Scientific Lab., NM). 1974.

From 8. symposium on explosives and pyrotechnics; Los Angeles, California, USA (5 Feb 1974).

In Proceedings of the 8th symposium on explosives and pyrotechnics.

Recent experiments have shown that a particular secondary explosive can be reliably ignited with a reacting metal bridgewire. This innovation, together with improved header designs, is feasible for hot wire electroexplosive devices. The removal of primary explosive, together with physical design improvements, results in a class of electroexplosive devices which exhibits markedly lowered electrostatic and electromagnetic radiation susceptibility (particularly in the pins-to-case mode) without appreciable increases in normal mode firing energy. (auth)

5544 (CONF-740216—, pp 4.1-4.6) **Thermal ignition of pyrotechnics through a bulkhead.** Kjeldgaard, E.A.; Gould, D.J. (Sandia Labs., Albuquerque, NM). 1974.

From 8. symposium on explosives and pyrotechnics; Los Angeles, California, USA (5 Feb 1974).

In Proceedings of the 8th symposium on explosives and pyrotechnics.

An electrically ignited donor pyrotechnic charge is used as a heat source of sufficient intensity to cause ignition of an acceptor charge isolated from the donor charge by a metal bulkhead. This system is applicable to incompatible pyrotechnic mixes and may also be used as a safety device. Total function times are dependent upon burn rates, heat capacities, ignition temperatures, charge sizes and densities, geometry, and bulkhead material and thickness. An interesting application that this design allows is ignition of an acceptor material that may be under, or generate, high pressure. (auth)

5545 (CONF-740216—, pp 18.1-18.6) **Critical energy for shock initiation of fuze train explosives.** Walker, F.E.; Wasley, R.J.; Green, L.G.; Nidick, E.J. Jr. (Univ. of California, Livermore). 1974.

From 8. symposium on explosives and pyrotechnics; Los Angeles, California, USA (5 Feb 1974).

In Proceedings of the 8th symposium on explosives and pyrotechnics.

Results of shock initiation experiments conducted in a gun system with tetryl and A-5 are presented, along with some data on the shock initiation of other explosives. An equation which has been useful in correlating these shock data is given. Some applications of this critical energy concept to explosive train designs for NASA space systems are included. (auth)

5546 (CONF-740216—, pp 19.1-19.12) **Detonation transfer by flyer plate impact.** Kennedy, J.E.; Schwarz, A.C. (Sandia Labs., Albuquerque, NM). 1974.

From 8. symposium on explosives and pyrotechnics; Los Angeles, California, USA (5 Feb 1974).

In Proceedings of the 8th symposium on explosives and pyrotechnics.

Detonation is often transmitted between elements in an explosive train by driving a solid plate or fragments across a gap to impact the acceptor explosive charge. An analytical model is presented which treats such transfer of detonation. Acceleration of the flyer plate is described by the Gurney relations. When the acceptor explosive has a small column dia, it is further required that detonation be established promptly, within a short shock travel distance into the explosive. This condition is shown to alter the optimum choice of flyer material in favor of high-impedance metals. (auth)

5547 (MHSMP—75-24J) **Mechanical and frictional behavior of 4.5 KG skid test billets. Period covered: April—June 1975.** Van Velkinburgh, J.H. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. 9p. Dep. NTIS $4.50.

Accelerometer instrumented vertical drop tests and skid tests were performed on 209.6 mm diameter (~ 4.5 kg) hemispherical samples of PBX 9011, PBX 9404, LX-04 and LX-14. Vertical drop tests were done from heights of 19 to 610 mm. Skid tests were done at both 14 and 45° impact angles and from heights of 0.53 to 2.16 m. The measured mechanical behavior, deduced mechanical material properties and frictional sensitivity are described. (auth)

5548 (MHSMP—75-29) **Disposal of waste or excess high explosives. Progress report, April—June 1975.** (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 39p. Dep. NTIS $4.00.

Progress during April to July 1975 in research on the disposal of waste high explosives is reported. Evaluation of the full-scale test incinerator (closed-pit, batch-type) at the ERDA Pantex Plant continued. Air and I-beam temperature levels during combustion were acceptable. Surface temperatures within the incinerator created by radiated heat are high, resulting in a high temperature gradient both in the I-beams and the concrete walls. The I-beams deflected elastically as much as 2.5 cm. Venting (the release of flames above the sand filter bed) was observed only for burn rates in excess of 36 kg/sec with 5.1 cm of sand. With the aid of the blowers the I-beams were cooled to within 10° of ambient 2 h after the burn. (auth)

5549 (MHSMP—75-40C) **LX-10 pressing studies. Period covered: July—September 1975.** Harrell, J.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 4p. Dep. NTIS $3.50.

Progress during July to October 1975 in research on chemical explosives is reported. Pressing LX-10 to densities at or above 1.865 Mg/m^3 will require multiple cycles. The best approach appears to be formation of the basic part via the standard wet-bag assembly and repress in a captive-water system for an extended period of time. (auth)

5550 (MHSMP—75-40D) **Mechanical properties of LX-14. Period covered: July—September 1975.** Johnson, H.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 12p. Dep. NTIS $3.50.

Progress during July to October 1975 in research on chemical explosives is reported. A 4.54 Mg Holston shipment of LX-14 Lot 713-1 (95.5 percent HMX/4.5 percent Estane) was evaluated for mechanical properties. The 21 C and the -37 C tensile test average failure stresses were 3.72 MPa and 5.64 MPa. (auth)

5551 (MHSMP—75-40E) **TATB synthesis activities.** Quinlin, W.T.; Evans, V.H.; Estes, Z.L.; Schaffer, C.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 11p. Dep. NTIS $3.50.

During the first quarter of FY 76 the Pantex Synthesis Facility continued the development of TATB processing and the production of TATB. A total of 2027 kg TCTNB and 1317 kg TATB were made. Of the TATB produced, 234.8 kg was made from TCTNB purchased from Teledyne, McCormick Selph. (auth)

5552 (MHSMP—75-40F) **TATB PBX formulations.** Johnson, H.D.; Osborn, A.G.; Stallings, T.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 26p. Dep. NTIS $4.00.

Progress during July to October 1975 in research on chemical explosives in reported. A series of six processing parameter studies were conducted in the 30-liter reactor. Batch concentration emerged as the most important single variable affecting physical properties other than granule size which has previously been reported. (auth)

5553 (MHSMP—75-40G) **Numberical method for titration end point determination. Period covered: July—September 1975.** Ashcraft, R.W. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 5p. Dep. NTIS $3.50.

Progress during July to October 1975 in chemical explosive research is reported. A numerical method has been utilized to determine analytically the end point of a potentiometric titration. The method has been programmed for the Wang 700 calculator to aid in the chlorine analysis of TATB. Significant time is saved by using the program because it is no longer necessary to run the entire titration curve and tedious, error-prone graphical techniques of solution are eliminated. (auth)

5554 (MHSMP—75-40P) **Determination of absolute molecular weights nitrocellulose by gel permeation chromatography. Period covered: July—September 1975.** Jacobs, B.J.; Blythe, R.A.; MacDougall, C.S.; Teter, A.C. (Mason and Hanger-Silas Mason Co.,

Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 8p. Dep. NTIS $3.50.

Progress during July to October 1975 in research on chemical explosives is reported. Vapor pressure osmometry was used to determine absolute molecular weights of three different grades of nitrocellulose. Nitrocellulose samples of 250-750 mg were weighed into 10 ml volume flasks and dissolved in tetrahydrofuran. The solutions were run against tetrahydrofuran solvent and the molar concentrations were determined by comparing values of ΔR for the samples with a calibration curve. The molecular weight of each of the nitrocellulose samples was then calculated from the sample weight and molar concentrations. These results were then correlated with GPC measurements to obtain a correct "Q factor." (auth)

5555 (MHSMP—75-40R) **Data reduction of GPC spectra. Period covered: July—September 1975.** Askcraft, R.W. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 4p. Dep. NTIS $3.50.

Progress during July to October 1975 in research on chemical explosives is reported. A program has been developed for the Wang 700 to provide on-line analysis of GPC spectra. By eliminating tedius hand calculations and measurements the program has provided a fast, accurate technique for the data reduction. (auth)

5556 (MHSMP—75-40S) **Sensitivity and performance testing of HE. Period covered: July—September 1975.** Kramer, P.E. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 6p. Dep. NTIS $3.50.

Progress during July to October 1975 in research on chemical explosives is reported. The effort to establish a simple, accurate, and inexpensive method for measuring detonation pressures (C-J pressure) of explosives was reactivated, with attention being focused on a technique previously investigated at LLL. Acceptable results were obtained with PBX 9404, LX-04, and CB-3, but not with TNT. (auth)

5557 (MHSMP—75-52) **Disposal of waste or excess high explosives. Progress report, July—September 1975.** (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 29p. Dep. NTIS $4.00.

Progress during July to Oct. 1975 in the development of the closed-pit batch-type incinerator for the disposal of high explosives (HE) is reported. Phase II, the study of temperature and pressure effects caused by large mass-flow-rates from burning explosives is complete and the data are presented. Based upon these findings this incinerator concept is technically feasible and the present incinerator design, with minor modifications, can meet the requirements of the future HE waste disposal plan at the Pantex Plant. Future work concerning the pollution aspects of this incinerator design is discussed. (auth)

5558 (MHSMP—75-54A) **Mechanical properties of TATB/Kel-F 800. Period covered: July—September 1975.** Johnson, H.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 14p. Dep. NTIS $3.50.

Progress during July to October 1975 in research on chemical explosives is reported. The growth of thermally cycled RX-03-BB dimensional stability specimens was reduced by confinement to 2.0 mm/m with a preloading of 69 kPa and to 0.5 mm/m with a preloading of 1379 kPa. The growth of unconfined specimens is 3.0-3.5 mm/m. The density loss due to growth for confined specimens ranged from 0.003 to 0.007 Mg/m^3 compared with 0.019 Mg/m^3 for unconfined specimens. The compressive strength of LLL B7 is significantly higher than Blend 6. The tensile strength and elongation of B6 and B7 are approximately the same. (auth)

5559 (MHSMP—75-54B) **Thermal properties, July—September 1975.** Myers, L.C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487. 28p. Dep. NTIS $4.00.

For Lawrence Livermore Lab., CA.

A complete series of thermal tests was made to evaluate the compatibility of LX-10 and RX-03-BB with three new adhesives. The adhesives were special formulations. There was no indication that the adhesives were reactive with RX-03-BB at temperatures below 423°K. With LX-10 there was an indication that two of the adhesives were slightly reactive at 393°K. Thermal decomposition data for PETN samples with different particle sizes are compared, and at 393°K the decomposition rate is particle size dependent, but at 383°K the rate is independent of particle size. An investigation of the variations in the chemical reactivity test data has shown that part of the variations result from a change in the sensitivity of the instrument's detector. Tests were conducted on a gas mixture and PBX 9404 over a period of eight days and the standard deviation for the total volume of gas evolved from PBX 9404 was 3.8 percent. By normalizing the PBX 9404 data using the gas mixture data, the standard deviation was reduced to 1.3 percent. (auth)

5560 (SAND—75-0500) **Data acquisition system for transient pulse testing.** Strasburg, A.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. Contract AT(29-1)-789. 25p. Dep. NTIS $4.50.

The transient pulse test is a nondestructive means for characterizing the bridgewire/explosive interface of a hot-wire explosive device. It produces an analog of resistance change in response to a square-wave electrical signal. A system has been devised to interpret the response using digital data processing equipment. The electrothermal analog is recorded as a series of discrete digital values. A programmable calculator reduces these data to mathematical expressions representing the initial and final states of the primary time constant. These expressions allow direct calculation of bridgewire interface parameters. (auth)

5561 (SAND—75-5225) **Initiation and detonation studies of condensed explosives using interferometric techniques.** Kennedy, J.E.; Nunziato, J.W.; Hardesty, D.R. (Sandia Labs., Albuquerque, N.Mex. (USA); Sandia Labs., Livermore, Calif. (USA)). 1975. 29p. (CONF-750912—3). Dep. NTIS $5.00.

From 5. international colloquium on gasdynamics of explosions and reactive systems; Bourges, France (8 Sep 1975).

A laser interferometer system for measuring the particle velocity history of a diffuse reflector, and related experimental techniques which are applicable to the study of shock and detonation behavior of condensed-phase explosives are described. The wide range of interferometric studies currently in progress which are aimed at obtaining new and more accurate data concerning the thermomechanical and thermochemical properties of explosives are discussed. These studies include work on the shock initiation of the heterogeneous and homogeneous explosives, PBX-9404 and liquid nitromethane, respectively. Both of these studies have provided quantitative information for the estimation of the overall reaction kinetics of condensed-phase explosives under shock loading. (auth)

5562 (UCRL—51892) **Determination of equation-of-state parameters for four types of explosive.** Penn, L.; Helm, F.; Finger, M.; Lee, E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Aug 1975. Contract W-7405-Eng-48. 32p. Dep. NTIS $4.00.

The detonation parameters of a representative of each of four types of commercial explosive (a mixture of ammonium nitrate and fuel oil, commonly called ANFO, a traditional stick dynamite, an aluminized slurry blasting agent, and a nonaluminized slurry blasting agent) were determined experimentally by instrumented cylinder and hemisphere tests. The equation-of-state parameters for each of the materials were then calculated by using the J-W-L equation of state. (auth)

5563 **Isothermal linear and volume compression of pentaerythritol tetranitrate (PETN) to 10 GPa (100 kbar) and the calculated shock compression.** Olinger, B.; Halleck, P.M.; Cady, H.H. (Los Alamos Scientific Lab., NM). *J. Chem. Phys.*; 62: No. 11, 4480-4483(1 Jun 1975).

The isothermal and volume compressions of the explosive pentaerythritol tetranitrate (PETN) were measured to 10 GPa using a high pressure x-ray diffraction technique. Data on linear and volume compression are plotted for pressures from 0 to 10 GPa, and fits to the data plots are derived. The shock compression Hugoniot of PETN calculated from the isothermal compression fit is $u_1 = 2.24 + 2.95\ u_2 - 0.605\ u_2^2$, for u_2 less than 1.00 km/s and $u_1 = 2.81 + 1.75\ u_2$ for u_2 greater than 1.00 km/s, where u_1 is the shock velocity and u_2 is the particle of mass velocity behind the shock wave. The isothermal compression fit and the Hugoniot are initially quadratic because of the rapid change in the strength of repulsive forces between the PETN molecules during initial compression. (LCL)

5564 **Nitrodifluoraminoterphenyl compounds and processes.** Lerom, M.W.; Peters, H.M. (to U.S. Atomic Energy Commission). US Patent 3,894,086. 8 Jul 1975. Filed date 20 Apr 1972. 14p.

PAT-APPL-246,031.

This patent relates to the nitrodifluoraminoterphenyl compounds: 3,3''-bis (difluoramino)-2,2'' 4,4', 4'',6,6',6''-octanitro-m-terphenyl (DDONT) and 3,3''-bis(difluoramino)-2,2',2''4,4',4'',6,6',6''-nonanitro-m-terphenyl (DDNONA). Procedures are described wherein diamino precursors of the indicated compounds are prepared and the final compounds are obtained by a fluorination operation. The compounds are highly energetic and suitable for use as explosives and particularly in exploding bridge wire (EBW) detonators. (auth)

5565 Miniature igniter. Craig, J.R.; Villa, F.J. (to U.S. Energy Research and Development Administration). US Patent 3,906,858. 23 Sep 1975. Filed date 30 Jul 1974. 8p.
PAT-APPL-493,007.

This patent concerns a miniature igniter with pair of electrically conductive spaced apart and recessed members, an electrically insulative plate between the members also having a recess, all of said recesses forming a cavity for a charge, a bridgewire spanning the plate to connect the conductive members, charge material over the bridgewire, and connector pins in electrical connection with the conductive members. (auth)

5566 From cellular structure to failure waves in liquid detonations. Urtiew, P.A. (Univ. of California, Livermore). *Combust. Flame;* 25: No. 2, 241-245(Oct 1975).

Present understanding of cellular structure in gaseous detonations is used to interpret observations in liquid explosives. Dark waves, failure waves, and wall traces are examined and brought into full accord. The origin and growth of failure waves are explained on the basis of transverse motion and reflection of the triple-wave intersections characteristic of cellular structures. (auth)

NUCLEAR

CIVIL USES

5567 (NVO—155(Vol2.)) **In situ leaching of a nuclear rubblized copper ore body. Volume II. Detailed design, calculations, and procedures.** (Energy Research and Development Administration, Washington, D.C. (USA); Kennecott Copper Corp., Salt Lake City, Utah (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1975. 352p. Dep. NTIS $10.60.

5568 (PNE-RB—71) **Vibration response and evaluation of oil shale mine openings to the Rio Blanco event.** Munson, R.D. (Bureau of Mines, Denver, Colo. (USA). Denver Mining Research Center). 10 Jul 1975. Contract AT(29-2)-914. 59p. Dep. NTIS $5.50.

Project Rio Blanco was designed to further study the economic and technical feasibility of the commercial development of natural gas, using underground nuclear explosions to stimulate production. Simultaneous detonation of the three, 30 kt devices took place on May 17, 1973, at 10:00:00.12 hours +-0.01 second, M.D.T. The initial compressional impulse was evident on all data channels at the Colony, Anvil Points and Dutch Creek No. 1 Mines. Other phases were not readily identifiable due to the complexity of the seismic signals. Recorded particle velocity and acceleration were, in general, near that predicted for the event. Particle velocity was directly recorded from all station points. Acceleration was directly recorded only from selected stations for comparative purposes. Displacement was derived for all station points from recorded particle velocity and/or acceleration. Propagation velocity was calculated to be 13,950 feet/second to the Colony Mine and 15,800 feet/second to the Anvil Points Mine. In view of the fact that both mines lie very nearly on a common line to ground zero, a higher velocity to the Anvil Points mine is unique. This may indicate the presence, at depth, of a high velocity refraction layer through which the seismic wave to both mines was transmitted. Loss of the transmitted time signal at the Dutch Creek No. 1 mine station prevents calculation of the propagation velocity. (auth)

5569 (UCRL—52000-75-10, pp 20-25) **Nuclear chemical mining for copper recovery.** Oct 1975.

In Lawrence Livermore Laboratory energy and technology review.

To meet projected domestic demand for copper, deeper ore deposits will have to be exploited and a technology developed for processing these ores. LLL has investigated combining nuclear technology and in situ leaching to recover copper ores from deposits too deep to be mined economically by conventional techniques. The chemical mining concept involves emplacing nuclear explosives below the water table in a deep-lying copper deposit, detonating these explosives to rubblize the rock, and then passing oxygen and water through the rubblized zone to leach out the copper as copper sulfate. The copper sulfate is then brought to the surface where liquid ion exchange and electrowinning are used to remove the copper. Technical evaluations of this chemical mining process have been favorable. In 1973, LLL teamed with the Kennecott Copper Corporation and ERDA to consider the feasibility of commercializing the process. The resulting joint study affirmed the technical feasibility of nuclear chemical mining and identified the process uncertainties that must be resolved before its commercial feasibility can be assured. (auth)

5570 Rio Blanco experiment: its objectives, design, and execution. Luetkehans, G.R. (CER Geonuclear Corp., Las Vegas, NV); Toman, J.; DiBona, B.G. *Nucl. Technol.;* 27: No. 4, 539-558(Dec 1975).

Project Rio Blanco is a joint government-industry experiment utilizing nuclear explosives to stimulate gas production from thick, relatively impermeable, gas-bearing lenticular sand and shale sequences. Three 30-kt explosives spaced vertically in a single wellbore at intervals of 390 and 460 ft were detonated simultaneously on May 17, 1973. No significant adverse effects were experienced, and damage resulting from ground motion was as predicted. The initial reentry into the upper explosive region indicates that coalescense of the top cavity and fracture region with the lower ones did not occur as expected. Reentry into the bottom cavity indicated that similarly, communication does not exist between the lower two chimneys. The fracture height of the upper region was about as predicted from previous experience with single-chimney geometry as was the cavity radius resulting from the bottom detonation. All indications are that yields were as predicted, and to date there is no valid explanation as to the lack of intercommunication between the fracture regions of the three explosives. Production test data from the top chimney indicated a reservoir capacity of only 0.73 md-ft, which is 6 to 10 times lower than expected. Subsequent testing of an evaluation well and other data lends further evidence that, although significant stimulation most surely occurred, the gas contained in the sandstones was much less than had been originally anticipated. Properties deduced from production test data from the bottom chimney are in much better agreement with predetonation estimates. Further investigations are required to fully evaluate the experiment. (auth)

5571 Rio Blanco: nuclear operations and chimney reentry. Woodruff, W.R.; Guido, R.S. (Univ. of California, Livermore). *Nucl. Technol.;* 27: No. 4, 559-622(Dec 1975).

Rio Blanco was the third experiment in the U.S. Atomic Energy Commission's Plowshare Program to develop technology to stimulate gas production from geologic formations not conducive to production by conventional means. The project was sponsored by CER Geonuclear Corporation, with the Lawrence Livermore Laboratory providing the explosives and several technical programs, such as spall measurement. Three nuclear explosives specifically designed for this application were detonated simultaneously in a minimum-diameter emplacement well using many commercially available but established-reliability components. The explosive system performed properly under extreme temperature and pressure conditions. Emplacement and stemming operations were designed with the aim of simplifying both the emplacement and reentry and fully containing the detonation products. An integrated command and control system was used with communication to all three explosives through a single coaxial cable. Reentry and the initial production testing are completed. To date 98 million standard ft^3 of chimney gas have been produced. (auth)

5572 Modification of the colony tower for the Rio Blanco detonation. Blume, J.A.; Freeman, S.A.; Honda, K.K.; Lee, L.A. (URS/John A. Blume, and Associates, Engineers, San Francisco). *Nucl. Technol.;* 27: No. 4, 623-630(Dec 1975).

Supplemental structural bracing was designed and installed for the 180-ft-tall Colony Tower, an experimental oil shale processing retort structure, in anticipation of its lateral response to the Rio Blanco detonation. The tower is a steel structure with both horizontal and vertical diagonal bracing. Data obtained from the earlier Project Rulison detonation indicated that an evaluation study was necessary. Design criteria that would provide an adequate margin of safety were developed based on predicted Rio Blanco ground motion. The evaluation of the unmodified structure showed that several bracing members would be subjected to forces exceeding their yield strength, and some would reach a level at which failure could occur. Further analyses were made with assumed modified bracing members. A final scheme for modified vertical bracing was established and installed. After modification, the response of the tower during the Rio Blanco detonation was measured by instruments on the ground and at various locations on the tower, and no evidence of damage was discovered. The modification of the Colony Tower and the procedures used to determine these modifications show the usefulness of current ground motion and structural response prediction technology for forecasting dynamic behavior of important structures subjected to ground motion from underground nuclear explosions. (auth)

5573 Project Rio Blanco ground motion studies. Alcock, E.D. (CER Geonuclear Corp., Las Vegas, NV). *Nucl. Technol.;* 27: No. 4, 631-639(Dec 1975).

A major instrumentation program was undertaken for the Rio Blanco experiment to measure the ground motion at various azimuths and distances from the emplacement well. Another instrumental array was fielded to detect the change, if any, in the

seismicity of the area due to the experiment, and to detect and locate the hypocenters of the aftershocks. The various effects of the ground motion were less than the predetonation predictions. The post detonation damages paid to date are $57,872 as compared to the predetonation prediction of $51,300 +- $13,200 for low-rise structures alone. (auth)

5574 Rio Blanco experiment: subsurface and surface effects and measurements. Toman, J.; Sisemore, C.; Terhune, R. (Univ. of California, Livermore). *Nucl. Technol.*; 27: No. 4, 640-652(Dec 1975).

A major instrumentation program undertaken in the Rio Blanco experiment involved the burial of 20 accelerometers and 16 velocity gauges at varying depths from the ground surface and distances from the emplacement well. The objective was to measure the extent of spall (tensile failure of the earth materials). A preliminary analysis of the accelerometer data indicates that the Rio Blanco spall zone can be described as a broad shallow dish with a most probable depth of less than 350 ft and a radius of less than 24,000 ft. Spalled material experiences a period of free fall (-1-g acceleration) that can be identified in both acceleration and velocity traces. Acceleration records show conclusively that spall occurred above 149 ft at the emplacement well, but not below 604 ft. Instruments placed at depths of 350 and 450 ft appear not to have recorded spall characteristics, but these records must be analyzed in greater detail for a definitive statement. The results are in general agreement with predetonation predictions. (auth)

5575 Heating effects in Rio Blanco rock. Taylor, R.W.; Bowen, D.W.; Rossler, P.E. (Univ. of California, Livermore). *Nucl. Technol.*; 27: No. 4, 653-659(Dec 1975).

Samples of "sandstone" from near the site of the upper Rio Blanco nuclear explosion were heated in the laboratory at temperatures between 600 and 900°C. The composition and amount of noncondensable (dry) gas released were measured and compared to the amount and composition of gas found underground following the explosion. The gas released from the rock heated in the laboratory contained approximately 80 percent CO_2 and 10 percent H_2; the balance was CO and CH_4. With increasing temperature, the amounts of CO_2, CO, and H_2 released increased. The composition of gas released by heating Rio Blanco rock in the laboratory is similar to the composition of gas found after the nuclear explosion except that it contains less natural gas (CH_4, C_2H_6 . . .). The amount of noncondensable gas released by heating the rock increases from approximately 0.1 mole/kg of rock at 600°C to 0.9 mole/kg at 900°C. Over 90 percent of the volatile components of the rock are released in less than 10 h at 900°C. A comparison of the amount of gas released by heating rock in the laboratory to the amount of gas released by the heat of the Rio Blanco nuclear explosion suggests that the explosion released the volatile material from about 0.42 mg of rock per joule of explosive energy (1700 to 1800 tonnes per kt). (auth)

5576 Pore pressure enhancements observed on Rio Blanco. Banister, J.R.; Ellett, D.M. (Sandia Labs., Albuquerque, NM). *Nucl. Technol.*; 27: No. 4, 660-679(Dec 1975).

Measurements were made of the change of in situ pore pressures and the associated accelerations in the saturated clayey silts (ML) of Fawn Creek and Black Sulphur Valleys at 2.1, 4, 7, and 10 km from surface zero. The early pore pressure changes correlated well with accelerations while the later values correlated better with velocities. The pressure changes ranged from 17.1 to 0.36 psi for the peak pressures and from 1.7 to 0.10 psi for the average pressure increases 10 sec after the detonation. Pretest estimates indicated that liquefaction was considered probable but it was not observed and the pore pressure increases were one-quarter or less than those associated with this phenomenon. (auth)

5577 Verifying the coherency transfer function ground motion predictions for multiple underground explosions. Power, D.V. (El Paso Natural Gas Co., TX). *Nucl. Technol.*; 27: No. 4, 680-691(Dec 1975).

The coherency transfer function (CTF) is a method for summing seismograms from multiple nearly coherent sources by using a frequency domain transformation. Ground motion predictions for the nuclear explosive Rio Blanco experiment are calculated for peak vector amplitudes of acceleration, velocity, and displacement and are compared to the Rio Blanco data and the results of other prediction techniques. Predictions of amplitudes are higher than experimental results by a few percent for acceleration and displacement and by 20 percent for velocity. Data regression slopes are approximately 12 percent greater than predicted values for acceleration but less than 5 percent greater for displacement and velocity. CTF predictions are found to agree with experimental results as good as or better than values predicted by other methods. (auth)

5578 Production test data and preliminary analysis of top chimney/cavity. Toman, J. (Univ. of California, Livermore). *Nucl. Technol.*; 27: No. 4, 692-704(Dec 1975).

The reentry drilling established communication with the top Rio Blanco detonation region at a depth of 1704 m, or approximately 76 m above the top detonation center. A total of 2.8 x 10^6 m^3 (98 x 10^6 ft^3) of dry gas at standard conditions has now been produced during two separate test periods. Radioactive and chemical analysis of this gas and the modeling of the stimulated reservoir show the following main results: 1. No permeable connection exists between the top and the middle detonation regions, since no significant amount of the tracer incorporated in the center explosive canister was detected in the produced gas. As a consequence, results for the top detonation region only are available at this time. 2. The initial cavity radius is deduced to be 20 m (66 ft) or well within expectations. 3. Integration of the ^{85}Kr produced indicates a yield of 34 +- 3 kt for the top explosive. 4. Of the approximately 1000 Ci of tritium produced in the top explosion region, approximately 5 percent is incorporated in the gas phase. 5. Pressure drawdown and buildup data are best reproduced by a two-layer reservoir model showing stimulated permeabilities approximately 10 and 30 times original formation permeabilities, and extending to a distance of approximately 3 cavity radii from the wellbore. 6. The capacity of the reservoir intercepted by the top explosive is deduced to be approximately 0.2 millidarcymeters (md-m) [0.73 millidarcy-feet (md-ft)], as contrasted with preshot estimates ranging from 1.3 md-m (4.1 md-ft) to 2.3 md-m (7.6 md-ft). Additional subsurface investigations of the other detonation regions, as well as a reevaluation of the initial reservoir properties, are in progress. (auth)

WEAPONRY

5579 (UCID—16894) **Equalizing cable to transmit wideband pulse-like, and rising exponential analog waveforms: a new survey.** Bukofzer, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Sep 1975. Contract W-7405-Eng-48. 59p. Dep. NTIS $5.50.

The problem of transmitting wideband analog waveforms through cable systems is examined. Classes of analog waveforms are defined, cables are modeled, and a cable measurement system that generates equalization data is described. Errors that occur at the output of cable systems, and bounds on these errors, are analyzed. System improvements, which could be implemented provided certain technological developments take place, are discussed. Suggestions for such improvements are presented in the form of short informal proposals that could be expanded into formal proposals at a later date. (auth)

5580 (UCID—16910(Pt.1)) **LLL DBASE glossary and parameter definitions, Part 1.** Rohrer, R.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Oct 1975. Contract W-7405-Eng-48. 63p. Dep. NTIS $5.45.

This report lists, defines, and updates parameters in DBASE, an LLL test effects data bank in which data is stored from experiments performed at NTS and other test sites. Parameters are listed by subject and by number. Part 2 of this report presents the same information for classified parameters. (auth)

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

5581 (UCRL-77419) **Uncertainties in the validation of parameterized transport in 1—D models of the stratosphere.** Chang, J.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1975. Contract W-7405-Eng-48. 25p. Dep. NTIS $4.50.

The two basic components in any theoretical model of the stratosphere are the photochemical kinetic processes and the dynamic transport processes. A model was constructed in which an attempt was made to describe all the essential photochemistry and to represent the principal transport mechanism in the stratosphere. Due to various limitations many of the detailed physical processes were simplified and parameterized. It was concluded that there exists a need to better quantify the uncertainties in the model predictions on the possible ozone perturbations in the stratosphere by supersonic transport operations. Therefore, a thorough analysis of the parameterized transport as used in these models is required. Both natural chemical tracers and man-made radionuclides may be used in assessing the accuracy of the model transport and each is discussed. Almost all conclusions apply equally well to the multi-

dimensional models, although the present discussions are centered on the one-dimensional models. (CH)

5582 (AECL—5252) **Least-squares fits to wind profiles measured over snow.** Selander, W.N. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Sep 1975. 11p. Dep. NTIS (US Sales Only) $4.50 AECL $0.50.

Based on least squares fits by logarithmic functions, it is found that wind profiles measured over snow represent aerodynamically smooth or rough flow, depending on whether the snow cover is deep or thin and intermittent. The relation between friction velocity and the one-meter wind speed for the smooth flows is in good agreement with that previously found from measurements over a smooth water surface. (auth)

5583 (ATDL—75/17) **1974 annual report.** (National Oceanic and Atmospheric Administration, Oak Ridge, Tenn. (USA). Atmospheric Turbulence and Diffusion Lab.). Sep 1975. 240p. Dep. NTIS $10.60.

Separate abstracts were prepared for 12 sections of this report. Six items have been announced in Nuclear Science Abstracts and all twelve items have been announced in ERDA Research Abstracts. (CH)

5584 (COO—2195-21) **Radiative-diffusive models of the artic boundary layer.** Herman, G.F. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Meteorology). 25 Jul 1975. Contract AT(11-1)-2195. 170p. Dep. NTIS $7.75.

Thesis.

Self-consistent radiative-diffusive models that will predict the observed multiple stratus layers were developed. We consider the formation of Arctic stratus clouds in the relatively warmer and moister continental air as it flows over the pack ice. The initial profiles of temperature and relative humidity as well as their values at the surface are specified in advance, and the modification of the continental air is calculated as a time marching problem. Turbulent transport in the surface layer is parameterized by the Monin-Obukhov similarity formulation. Above the surface layer a simple mixing-length formulation is used, except in the unstable cases when a convective adjustment is used. Solar radiation is treated with Chandrasekhar's First Approximation. The water vapor spectrum in the NIR is represented with two grey absorption coefficients, and the cloud is treated as a grey scatterer and absorber. Thermal radiation is computed with emissivities. The cloud is a grey absorber and emitter in the thermal spectrum, and a mixed-emissivity is computed for the cloud-gas mixture. We find that condensation is induced in an initially unsaturated air mass due to diffusive cooling to the colder surface and longwave emission to space. Intense mixing within the cloud is generated by strong cooling due to droplet emission at the cloud top. A bi-layered structure develops, and we attribute this to a greenhouse mechanism whereby solar radiation penetrates to the interior of the cloud and causes evaporation there, while at the same time the top remains cold due to emission to space, and the lowest layer remains cold since the surface temperature is fixed at 0°C. A mechanism is also suggested for the lifting of a cloud top due to longwave emission in the clear atmosphere directly above the cloud. (auth)

5585 (COO—2249-5) **Transport processes and trace constituents in the stratosphere. Final report, May 1, 1972—September 30, 1975.** Cunnold, D.M.; Alyea, F.N. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Meteorology). 1975. Contract AT(11-1)-2249. 27p. Dep. NTIS $5.00.

A three-dimensional dynamical-chemical model of the stratosphere was developed. The model includes predictions not only of the dynamical structure of the stratosphere but also of atmospheric ozone. A three year integration of this model has produced seasonal and latitudinal variations of the zonal wind and of columner ozone which are similar to those observed. Additional model calculations have included the steady state nitrogen dioxide distributions resulting from a source of 1.8×10^8 tons/year inserted at various locations in the lower stratosphere. It is thus concluded that the most significant effect of a large fleet of SST's producing such an injection of NO_x is to deplete total atmospheric ozone by of order 10 percent. The latitudinal structure of this ozone depletion for various source locations is compared. (auth)

5586 **Climatic change: are we on the brink of a pronounced global warming.** Broecker, W.S. (Columbia Univ., Palisades, NY). *Science;* **189**: No. 4201, 460-463(8 Aug 1975).

If man-made dust is unimportant as a major cause of climatic change, then a strong case can be made that the present cooling trend will, within a decade or so, give way to a pronounced warming induced by carbon dioxide. By analogy with similar events in the past, the natural climatic cooling which, since 1940, has more than compensated for the carbon dioxide effect, will soon bottom out. Once this happens, the exponential rise in the atmospheric carbon dioxide content will tend to become a significant factor and by early in the next century will have driven the mean planetary temperature beyond the limits experienced during the last 1000 years. (auth)

RADIOMETRIC TECHNIQUES

5587 **Carbon-14 as an indicator of CO_2 pollution in cities.** Vogel, J.C.; Uhlitzsch, I. (National Physical Research Lab., Pretoria). pp 143-152 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The combustion of fossil fuels in cities, and especially in industrial areas, releases large quantities of carbon dioxide into the local atmosphere. This carbon dioxide does not contain carbon-14, with the result that the carbon-14 content of the atmospheric carbon dioxide is locally depleted. The degree of depletion provides a measure for the carbon dioxide pollution at the sampling site. Since growing plants represent a convenient average sample of the carbon dioxide in the air, the leaves of deciduous trees can be used for comparing the magnitude of local pollution in different localities during the summer growing period. A series of leaf samples collected in 1973 from Europe, North America and South Africa reveals the expected differences in the degree of pollution. Extreme instances occur in Scholven (Ruhrgebiet, Germany), where the average day-time carbon dioxide content during the summer months is found to be 8.7 percent above normal, and in Manhattan, New York City, where the corresponding figure is 6.4 percent. The technique can easily be extended to include the winter months by directly absorbing carbon dioxide in a hydroxide solution during different seasons. The proposed method is sensitive but much less time-consuming than the continuous measurement of the carbon dioxide concentration in the air. It thus lends itself to the monitoring of impact areas of pollution. (auth)

CHEMICALS MONITORING AND TRANSPORT

5588 (ATDL—75/17, pp 153-161) **Comparison of estimation procedures for over-water plume dispersion, September 1974.** Hosker, R.P. Jr. Sep 1975.

In 1974 annual report.

Effluent transport and diffusion over water is receiving increased study, largely because of the current interest in off-shore nuclear power plants. Dispersion estimations identical to those used over land are open to question because, for given weather conditions (e.g., clear skies, moderate wind), the over-water turbulence will differ greatly from that over land. This paper attempts to assess the predictive capability of techniques similar to those in general use, but which utilize descriptions of turbulence perhaps more appropriate to over-water flows. (auth)

5589 (BNL—20328) **Human responses to sulfur pollutants. Proceedings of a computer-based conference, September—November 1974, Upton, New York.** Morris, S.C.; Morgan, M.G. (eds.). (Brookhaven National Lab., Upton, N.Y. (USA)). 1974. Contract E(30-1)-16. 103p. (CONF-7409126—). Dep. NTIS $6.50.

From Conference on human responses to sulfur pollutants; Upton, New York, USA (20 Sep 1974).

The conference was organized by the Biomedical and Environmental Assessment Group (BEAG) at Brookhaven National Laboratory and was conducted on the FORUM computer conferencing system which is being developed by the Institute for the Future. An objective of the conference is the development of a quantitative assessment of the biomedical and environmental effects of the energy system. Another objective is cooperation with other investigators in order to integrate the most current scientific understanding and techniques into their assessments. (HLW)

5590 (BNWL-SA—5551) **Pollutant transformations in urban plumes.** Alkezweeny, A.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 3p. (CONF-751050—1). Dep. NTIS $4.50.

From 8. aerosol technology meeting; Research Triangle Park, North Carolina, USA (6 Oct 1975).

The aircraft was instrumented for the purpose of measuring the following: aerosol particle size distribution in the range of 0.01 μm to 5.0 μm, concentrations of Aitken particles, O_3, NO, NO_x, and SO_2, hydrocarbons, trace metals, and sulfate. A comprehensive diagnostic model of multicomponent advection, diffusion, and transformation was completed. In the absence of pollutant entrainment the concentrations of the total particles, in particular those of a diameter less than 0.06 μm and particles larger than 1 μ,

decreased in time. However, the concentrations of aerosol particles in the range of 0.06 to 0.9 μm increased. The total volume concentration of particles up to 2 μm in diameter also increased with time. (HLW)

5591 (CONF-740370—) **Proceedings of the fourth annual industrial air pollution control conference, Knoxville, Tennessee, March 28—29, 1974. State of the art of air pollution control techniques for industrial processes and power generation.** Noll, K.E.; Davis, W.T.; Walling, J.O. (eds.). (Tennessee Univ., Knoxville (USA). Dept. of Civil Engineering). 1974. 563p. Univ. of Tennessee, Knoxville $10.00.

From 4. annual industrial air pollution control conference; Knoxville, Tennessee, USA (28 Mar 1974).

Information was presented on air pollution problems associated with a wide range of industries. One item was included in Nuclear Science Abstracts and one item was abstracted for ERDA Research Abstracts. (SFL)

5592 (CONF-750967—11) **Environmental analysis of the operation of the ERDA facilities in Oak Ridge.** McWherter, J.R. (Oak Ridge National Lab., Tenn. (USA)). 1975. 7p. Dep. NTIS $4.00.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

An analysis of the environmental effects of current ERDA operations in Oak Ridge is being conducted to establish a baseline for the consideration of the environmental effects of additional facilities or modified operations in the future. An extensive ecological survey has been conducted for about one year; social and economic data were obtained; and an archaeological survey of the area was made. The facilities were described and the effluents associated with operations were quantified to the extent practical. The effects of effluent releases to the environment are being analyzed. The social effects of the ERDA facilities in Oak Ridge are also being studied. (auth)

5593 (DP—1374) **Savannah River Laboratory environmental transport and effects research. Annual report, 1974.** Crawford, T.V. (comp.). (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Jun 1975. Contract AT(07-2)-1. vp. Dep. NTIS $7.60.

5594 (EPRI-SR—11) **Conference proceedings: workshop on health effects of fossil fuel combustion products, Indian Wells, California, November 11—13, 1974.** Comar, C.L. (Electric Power Research Inst., Palo Alto, Calif. (USA)). May 1975. 74p. (CONF-741175—). NTIS $5.45.

From Workshop on health effects of fossil fuel combustion products; Indian Wells, California, USA (11 Nov 1974).

The scientific basis for decision making relating to research programs needed within the next ten years to define the health hazards to human populations from air pollution resulting from the combustion of fossil fuels is reviewed. It is pointed out that one of the largest gaps in the understanding required for decision making by the utility industry is the lack of knowledge about the direct effects of the products of fossil fuel combustion on human health. A list is presented of recommended research priorities that identifies general areas of research needed. Emphasis is placed on the health hazards of air pollution by NO_x and sulfur oxides. (CH)

5595 (SAND—75-8047) **Review of the toxicology of tellurium and its compounds.** Devlin, T. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 22p. Dep. NTIS $4.00.

Since tellurium is used in several programs at Sandia Laboratories, a knowledge of its toxic effects is important. This report summarizes studies conducted by many researchers through the years; the effects of tellurium on animals and humans is found to range from virtually harmless to lethal, depending primarily upon the compound and the dosage. Safety standards for industrial exposure are presented. There is presently no antidote for tellurium poisoning. (auth)

5596 (UCID—30120) **ND: a program to analyze data on air pollution in the San Francisco Bay area.** Keller, P.R.; Keir, R.A.; Stullich, T.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Oct 1975. Contract W-7405-Eng-48. 88p. Dep. NTIS $5.45.

A computer program is described through which a user can analyze air-pollution and meteorological data by plotting it on a TV screen. Working interactively at the terminal, he can inspect graphs of the raw data, sift the data to study only those aspects of interest (e.g., range of pollutant concentration in a particular geographical area) and plot the data as 3-D graphs. He can expand or condense the plot (zoom capability) and can change the scaling of the axes. In setting up visual displays such as the geographical and altitude distribution of a pollutant, the user can isolate trends in the data that are not as readily grasped by other methods. We demonstrate the routine by applying it to data obtained in flights over the San Francisco Bay Area. The ND computer program is available on the Livermore timesharing system. (auth)

5597 INSTRUMENTATION FOR MONITORING AIR QUALITY. CONFERENCE HELD AT BOULDER, COLORADO, AUGUST 14—16, 1973. Philadelphia; United States of America (USA); American Society for Testing and Materials (1974). 192p. (ASTM-STP—555; CONF-730838—). $15.25.

From Conference on instrumental monitoring for ambient air; Boulder, Colorado, USA (14 Aug 1973).

Sixteen papers were presented. One paper has been separately abstracted for ERDA Energy Research Abstracts. Performance, testing, design, and comparative evaluation of measuring methods are presented for various monitoring instruments. Pollutants covered include sulfur dioxide, nitrogen oxides, particulates, hydrocarbons, and ozone. (PCS)

5598 Techniques for continuous monitoring of hydrocarbons. Mack, D.A.; Hollowell, C.D.; McLaughlin, R.D. (Univ. of California, Berkeley). pp 52-73 of In Instrumentation for monitoring air quality. Philadelphia; American Society for Testing and Materials (1974).

From Conference on instrumental monitoring for ambient air; Boulder, Colorado, USA (14 Aug 1973).

See ASTM-STP—555; CONF-730838—.

Detection and monitoring of hydrocarbons, both total and specific, are reviewed with emphasis on the nonmethane components of the atmosphere. Techniques that form the basis of commercial instrumentation are presented with suggestions for further investigation. (PCS)

5599 Determining the extent of oxidation of sulfur dioxide in power plant plumes from isotopic ratio measurements. Newman, L.; Forrest, J.; Manowitz, B. (Brookhaven National Lab., Upton, NY). pp 63-76 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The extent of oxidation of sulphur dioxide to sulphate in the plumes of oil and coal fired power plants have been studied by sampling with a single engine aircraft. A new technique employing isotopic ratio measurements was employed in conjunction with simultaneous concentration measurements of sulphur dioxide and sulphate. The method is based on measuring the isotopic ratio of the $^{32}S/^{34}S$ naturally occurring in the fuel sulphur. Changes were experienced in these ratios due to chemical reactions in the atmosphere. These changes were measured and interpreted as to an implied reaction. A mechanism is postulated whereby the sulphur dioxide is in equilibrium with water on particulates originating from the fuel. The sulphur dioxide is immediately catalytically oxidized by constituents of the particulates. In the oil fired instance a pseudo second order mechanism depending on sulphur dioxide and particulate concentrations is indicated and no dependency on relative humidity observed. The rate of reaction is 1 $ppm^{-1} \cdot h^{-1}$. In the coal fired instance the particulate level is a factor of 3 less than in the oil fired plume and the extent of reaction is reduced by about that amount. (auth)

5600 Petrol with isotopically differentiated lead added. Magi, F. (Ente Nazionale Idrocarburi, Rome); Facchetti, S.; Garibaldi, P. pp 109-119 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975). (In Italian)

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

An experiment is proposed aimed at determining the role of motor traffic in the pollution of the environment by lead, in particular of air, soil, vegetation, food and the human body. The technique of determining the isotopic composition of lead, used in the right way, should enable the whole problem to be solved. It is intended to add lead with a constant isotopic composition different from that of normally occurring lead, whether natural in origin or otherwise, to petrol in at least two regions of Italy. Analyses of lead samples taken from the principal mines have shown that Australian lead (Broken Hill Mine) has quite a different isotopic composition. This lead will therefore be used to prepare the antiknock additives for petrol sold in the regions in question. Adequate sampling should make it possible to determine the contribution to pollution of lead from motor vehicle exhausts. The regions chosen for the experiment are Piedmont (city and province of Cagliari)—the first because of its high traffic density and level of industrialization, the second because of its remoteness and the lead content of the

soil, which may affect food. Both regions present favourable conditions for supplying petrol of the intended type. The experiment is intended to last three years; the petrol with Australian lead will be marketed for a period of 18 months. The first results of analyses of the isotopic composition of lead contained in atmospheric dust in the city of Turin and of lead from a number of blood samples are reported in the paper. (auth)

5601 New method of determining very slight traces of nitrogen peroxide (NO_2) in polluted atmospheres, by isotope dilution and mass spectrometry. Stevens, C.M.; Barat, F.; Nguyen-Nghi, H. (CEN, Saclay, France). pp 389-402 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975). (In French)

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The authors propose a new method of determining nitrogen peroxide (NO_2) in the atmosphere or the stratosphere at very low concentrations, of the order of pp10^9 by volume or even less. This method employs isotopic dilution with $^{15}NO_2$ followed by conversion into N_2 and isotopic analysis by mass spectrometry. It consists of mixing homogeneously a known quantity of $^{15}NO_2$ with the sample of air. After separation of H_2O, HNO_3, CO_2, and N_2O, the nitrogen peroxide is transferred to a silica reactor by trapping at -196°C. This reactor contains electrolytic copper which, when heated to 580°C for $1^1/_2$ h, reacts with NO_2 to give N_2. The ratio of masses 29 and 30, corresponding to $^{15}N^{14}N$ and $^{15}N^{15}N$, is then determined by mass spectrometry. The sensitivity of the method is limited by the contamination that occurs while processing the sample under analysis (by reagents or by the separation and the measurement equipment). If the experiment is well programmed, this contamination is reproducible and can at present be given as $(4.5 \pm 0.5) \times 10^{-2}$ mm³ (NTP) of N_2. This very sensitive method of determination was developed for the investigation of possible pollution of the stratosphere by supersonic aircraft. The authors have used it to measure the NO_2 content of the air at ground level at the Saclay Nuclear Research Centre (air sample taken in two minutes; content found: 56 and 74 pp10^9 by volume). Thanks to its sensitivity it could be used without major difficulties to determine the quantity of nitrates in food, soil and water, $^{15}NO_3^-$ being used as a tracer instead of $^{15}NO_2$. (auth)

5602 Use of sulfur-34 to measure the absorption rate of sulfur dioxide on the leaves of plants. Belot, Y. (CEN, Fontenay-aux-Roses, France); Bourreau, J.C.; Dubois, M.; Pauly, C. pp 403-416 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975). (In French)

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

A new method has been developed for measuring the rate of sulphur dioxide absorption by plants. This rate is deduced from the isotopic composition of the sulphur contained in plants before and after fumigation with ^{34}S-enriched sulphur dioxide, the production of which is also described. The fumigation, which is carried out in the field with a special device, is limited to a period of the order of tens of minutes so as not to alter the physiological state of the plant. In the next stage, the plant sulphur is transformed, by calcination under oxygen, into a soluble sulphate and then precipitated as barium sulphate, which is finally decomposed into pure sulphur dioxide at 1500°C, with no isotopic effects. Variations in the isotopic composition of the sulphur dioxide collected in this manner are determined very accurately with a double-focusing mass spectrometer. The experimental results indicate that one can measure a sulphur deposit of several micrograms per gram of plant with quite acceptable accuracy. (auth)

5603 Visibility of distant mountains as a measure of background aerosol pollution. Porch, W.M. (Univ. of California, Livermore); Ensor, D.S.; Charlson, R.J. *Appl. Opt.;* **14**: No. 2, 400-403(Feb 1975).

A relationship is developed between the visibility of distant mountains seen from an aircraft and a level of background aerosol pollution for a model atmosphere. It is found that the distance at which Mt. Rainier can be seen on clean-air days, which are typical of background aerosol levels, is consistent with the level of aerosol light-scattering measurements in other background situations. (auth)

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

5604 (BNWL-SA—5355) Interpretation of near-background environmental surveillance data by distribution analysis. Waite, D.A.; Bramson, P.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 23p. Dep. NTIS $4.50.

Large numbers of radionuclide/medium combinations exhibit log-normal distributed environmental concentrations when these are plotted for a location over time or for one time over many locations. That is, environmental data are distributed such that they yield a straight line when plotted on log-probability paper. Although the log-normal distribution has not been applied on a wide scale to radiological data, and does not seem to describe all nuclide-medium combinations, its usefulness for predicting the levels of radionuclides in the environs and in human diets is discussed. Because the data are presented graphically, the mean, standard deviation, expected upper limits, and any plant contribution can be readily determined visually. Quoting with confidence a geometric mean of value less than minimum detectable level is uniquely possible by means of distribution analyses and overcomes the divisive problem of how to deal with such results. Mathematical data transformation techniques that have been devised for investigating characteristics of data sets are described. (CH)

5605 (BNWL-SA—5482) Statistical distributions as applied to environmental surveillance data. Speer, D.R.; Waite, D.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-1830. 30p. (CONF-750967—19). Dep. NTIS $5.00.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

Application of normal, log normal, and Weibull distributions to environmental surveillance data was investigated for approximately 300 nuclide-medium-year-location combinations. Corresponding W test calculations were made to determine the probability of a particular data set falling within the distribution of interest. Conclusions are drawn as to the fit of any data group to the various distributions. The significance of fitting statistical distributions to the data is discussed. (auth)

5606 (ERDA—1540) Brookhaven National Laboratory environmental statement. (Brookhaven National Lab., Upton, N.Y. (USA)). Nov 1975. vp. Office of the Assistant Administrator, Washington, D.C.

Background radiation levels have been measured continuously at BNL with respect to external gamma exposure and activity levels in air, water, soil, grass, and milk. The amounts of radioactivity and other potential environmental contaminants in BNL effluents, as well as external radiation levels attributable to BNL sources, are measured, and an extensive environmental monitoring and sampling program is conducted to ascertain the increments, if any, within the regional ecological system of pollutants attributable to BNL effluents. The principal pathways of radiation exposure to man from BNL operations involve releases of waste to the atmosphere and the Peconic River and direct radiation both from experimental facilities and transportation of waste materials. The resulting whole-body dose to the population within 50 miles of the BNL site in 1973 was 0.001 percent of the dose received from natural background radiation, and the exposures to biota were similarly insignificant. Routine chemical releases to the atmosphere, the Peconic River, and the ground produce no perceptible impact on humans or biota; all such releases are well below applicable standard limits for off-site areas. Alterations of the physical environment by the addition of heat or nonionizing radiation resulting from BNL operations have had no measurable impact on humans or other biota. The accumulation of radioactive emissions from BNL and other existing and planned nuclear facilities within a 50-mile radius is small. Nonradioactive releases from BNL represent a small percentage of those from other sources in the region. Many BNL facilities use or generate materials that could produce environmental damage if released in an uncontrolled fashion. In the worst possible case, the resulting whole-body dose to the population within a 50-mile radius would be 0.166 percent of that received from natural background. (ERB)

5607 (HASL—297) Health and Safety Laboratory environmental quarterly, June 1, 1975—September 1, 1975. Hardy, E.P. Jr. (USAEC Health and Safety Lab., New York). 1 Oct 1975. 188p. Dep. NTIS $7.60.

This report presents current data from the HASL environmental programs, The Institute of Nuclear Science in Taiwan, and the Australian Radiation Laboratory. The initial section consists of interpretive reports and notes on global ^{90}Sr fallout in 1974, ^{90}Sr in human bone in 1974, and the HASL Regional Baseline Station at Lloyd, N. Y. Subsequent sections include tabulations of radionuclide levels in stratospheric air, surface air, deposition, milk, diet, tapwater, and human bone. A bibliography of recent publications related to environmental studies is also presented. (auth)

5608 (HASL—297(App.)) **Health and Safety Laboratory environmental quarterly, June 1—September 1, 1975.** (USAEC Health and Safety Lab., New York). 1 Oct 1975. 512p. Dep. NTIS $10.60.

Data are presented on the activity from fallout ^{90}Sr and ^{89}Sr in precipitation sampled at various world land sites during 1975; the gross γ activity in samples of surface air collected at various locations; the content of stable Pb in samples of surface air; and the content of ^{89}Sr and ^{90}Sr in samples of milk and drinking water collected in North, Central, and South America. (CH)

5609 (JUL—1220) **Future radioactive environmental pollution in the Federal Republic of Germany by radionuclides from nuclear power plants in normal operation.** Bonka, H.; Bieselt, R.; Brenk, D.; Bruessermann, K.; Darvas, J.; Laser, M.; Schnez, H.; Schwarz, G.; Vogt, K.J.; Winske, P. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany)). Jul 1975. 237p. (In German). Dep. NTIS (US Sales Only) $9.00.

The future radiation exposure of human populations is estimated based on important gaseous and liquid radioactive effluents, mainly tritium, ^{85}Kr, ^{129}I, ^{131}I and ^{133}Xe, from modern nuclear power plants and corresponding reprocessing plants and a prediction of nuclear power plant expansion over a period of approximately 100 years. The local and regional radiation exposure due to gaseous wastes as well as the potential radiation exposure due to liquid effluents released into surface waters and their use for drinking water purposes are considered. The results are compared to the natural radiation exposure of the population in the Federal Republic of Germany. It was concluded that the future additional radiation dose will be within the limits of the fluctuation of the natural radiation exposure if it is possible to retain tritium and ^{85}Kr at a rate of about 90 percent to 99 percent and iodine at a rate of about 99 percent to 99.8 percent in the large reprocessing plants. (auth)

5610 (KFK—2153) **Production and release of ^{89}Sr, ^{90}Sr, ^{103}Ru, ^{106}Ru, ^{134}Cs, ^{135}Cs, ^{137}Cs, ^{141}Ce, and ^{144}Ce by nuclear power plants and reprocessing plants and the expected radiological burden until the year 2000.** Schiesser, D. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Neutronenphysik und Reaktortechnik). Aug 1975. 172p. (In German). Dep. NTIS (US Sales Only) $7.75.

Thesis. Submitted to Karlsruhe Univ. (F.R. Germany). Fakultaet fuer Maschinenbau.

The environmental effects of the production of long-lived radioisotopes of the elements strontium, ruthenium, cesium, and cerium are summarized in this report together with the projected yields of ^{89}Sr, ^{90}Sr, ^{103}Ru, ^{106}Ru, ^{134}Cs, ^{135}Cs, ^{137}Cs, ^{141}Ce, and ^{144}Ce from nuclear power plants and other nuclear facilities. Specific production rates and the consequent release rates, representative of time are evaluated for the different types of nuclear power plants (1000 MWe). Estimated release rates from fuel reprocessing plants are also included, based on decontamination factors attainable at present. Local body burdens of human populations resulting from the releases of nuclides by nuclear power plants and reprocessing plants are estimated. Based on the forecasted development of nuclear facilities, the global accumulated activity released by these facilities until the year 2000 is calculated. (auth)

5611 (KFK-EXT—20/75-1) **Monitoring for environmental radioactivity at the Karlsruhe Nuclear Research Center in 1974.** Winter, M.; Tachlinski, W. (Kernforschungszentrum Karlsruhe (F.R. Germany). Abt. Strahlenschutz und Sicherheit). Aug 1975. 54p. (In German).

Monitoring for environmental radioactivity at the Karlsruhe Nuclear Research Center is the responsibility of the Radiation Protection Department. A description is given of the routine environmental monitoring program as approved by the competent supervising authority of the state of Baden-Wuerttemberg. Results obtained in 1974 are presented. A survey of special monitoring steps and of results of background measurements performed for two nuclear power stations presently under construction are included. (CH)

5612 (RISO-M—1808) **Estimation of population doses from a nuclear power plant during normal operation.** Nowicki, K. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1975. 102p. Dep. NTIS (US Sales Only) $6.50.

A model is presented for estimation of the potential external and internal radiation doses to people located within a distance of 1000 km from a nuclear power plant during normal operation. The model was used to calculate these doses for people living 200 to 1000 km from a hypothetical nuclear power facility sited near the geographical center of Denmark. Two sources of radioactivity considered include the unit release of 15 isotopes of noble gases and iodines and liquid effluent releases from two types of 1000 MWe Light Water Power Reactors (PWR and BWR). Parameter variations were made and analyzed in order to obtain a better understanding of the mechanisms of the model. (auth)

5613 (UCRL—76936) **Implications of sampling from a log-normal population.** Toy, A.J.; Lindeken, C.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Sep 1975. 19p. (CONF-750967—13). Dep. NTIS $4.00.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

The environmental radioactivity surrounding the Lawrence Livermore Laboratory (LLL) is typically log-normally distributed. The geometric standard deviation of radioactivity in all types of samples (air, water, soil, sewage, and vegetation) is about two. Hypothesis testing was done using the mean geometric standard deviation of these samples. Parametric studies demonstrated the effect of the number of background samples, the magnitude of tolerable errors, the variability of the sample population, and the precision of the analysis on the detectability of differences from natural and global fallout radioactivity. It was decided to accept an error probability of 50 percent that the analysis would show a sample to be different from background when, in fact, it was not, and an error probability of 5 percent that the analysis would show a sample to be background, when in fact, it was not. For these assumptions, an analysis must differ from background by a factor of 1.6 to indicate a statistical difference, and a sample must contain radioactivity a factor of 8.6 different from background to be 95 percent detectable with 50 percent confidence. The difference in the mean of two such populations which is 95 percent detectable with 50 percent confidence is 2.8 if six samples are taken from each population. Applications in monitoring ^{239}Pu diffusion are described. (CH)

5614 **Cell classification by laser light scattering: identification and separation of unstained leukocytes.** Salzman, G.C.; Crowell, J.M.; Martin, J.C.; Trujillo, T.T.; Romero, A.; Mullaney, P.F.; LaBauve, P.M. (Los Alamos Scientific Lab., NM). *Acta Cytol.*; **19**: No. 4, 374-377(1975).

We have used a flow-system cell sorter to separate unfixed, unstained human leukocyte cells into morphologically distinct populations based only on the intensity of 488-nm wavelength laser light simultaneously scattered by each cell at two different angles. Three populations were observed as distinct peaks in a two-parameter pulse-height distribution and were then physically sorted into separate classes and stained for cytological examination. The three groups consisted of lymphocytes, monocytes, and neutrophils. Each group contained between 77 and 98 percent of a single cell type. Blood from an irradiated monkey was also sorted and showed the presence of a fourth peak which consisted of 61 per cent eosinophils. Thus, multiangle light-scattering information from unfixed, unstained cells may be a promising technique for rapid morphologic analysis and may have application, for example, as a high-speed automated leukocyte differential. We anticipate that this method may be useful in other clinical applications where morphologic differences are diagnostically important. One of the principal advantages of the method is elimination of fixation and staining of the samples; this is a nondestructive testing technique. (auth)

5615 **Anthropogenic carbon-13 decrease in atmospheric carbon dioxide as recorded in modern wood.** Freyer, H.D.; Weisberg, L. (Nuclear Research Center, Juelich, Ger.). pp 49-62 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The increase of CO_2 in the atmosphere due to human activities is investigated by means of the stable carbon isotope record in modern wood. This is possible, because fossil fuels are labelled rather uniformly by a ^{13}C-deficit of about 18 percent relative to atmospheric CO_2. For the isotopic analysis cellulose was isolated from wood. Each sample, representing a five-year average, was measured after burning to CO_2 by means of mass spectrometry. Difficulties arise mainly from two sources: first, growth conditions are probably superimposed upon the expected trend, especially in the first years of the tree; and second, an isotopic exchange between atmospheric CO_2 and other geological carbon reservoirs may occur without any net flux. A regression curve, calculated for the last 60 years of an average of several freestanding trees, shows a delta^{13}C decrease of only 0.3‰. This does not mean, however, that the CO_2 excess in the atmosphere is only 12 percent of the man-made carbon dioxide, because the exchange of CO_2 with marine bicarbonate lowers the delta^{13}C labelling. Using a simple two-box model, consisting of atmosphere and ocean, a value of 30 percent for the excess CO_2 still present becomes more likely corresponding to an average residence time of 3.4 years for a CO_2 molecule in the atmosphere. (auth)

5616 Method of determination of source contribution to radioactive contamination of the atmosphere. Semova, R.V.; Ternovskii, I.A.; Tret'yakova, A.F. (Inst. of Atomic Energy, Moscow). pp 211-214 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975). (In Russian)

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

Gamma-spectrometric measurements of activity ratios of radionuclides in soil, atmosphere and gaseous wastes allow the source contribution to the radioactive contamination of the atmosphere to be determined rapidly and reliably. (auth)

5617 Releases of krypton-85 and tritium to the environment and tritium to krypton-85 ratios as source indicators. Schroeder, K.J.P.; Roether, W. (Univ., Heidelberg). pp 231-253 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

More than 95 percent of the krypton-85 that is at present observed in the environment on a global scale originates from the combined releases following nuclear-power generation and plutonium production, while atmospheric fusion-bomb testing accounts for the same percentage of the global tritium. The global inventories at the end of 1973 were 55 MCi (estimated uncertainty +- 10 percent) of krypton-85, and 2900 MCi (+- 25 percent) of tritium. From the excess of the global krypton-85 inventory over the amounts accounted for by the sources other than plutonium production, it is concluded that 130 tonnes of plutonium-239 have been produced up to 1970. Pronounced fractionation occurs between atmosphere and hydrosphere, in the sense that the concentration of krypton-85 is lowered, and that of tritium (being overwhelmingly in the form of a water molecule, HTO) is greatly increased, in the hydrosphere. Largely as a consequence of this fractionation, the environmental tritium to krypton-85 ratios cover a wide range, with values lowest in the troposphere (typical order of magnitude 10^{-1} Ci/Ci) and highest in continental surface water (approximately 10^{3}). Preliminary oceanic krypton-85 data are reported, which indicate that the concentration decrease with depth in the ocean is very similar for both nuclides. Effluents from nuclear power reactors and reprocessing plants have tritium to krypton-85 ratios that do not differ markedly from those found at present in the troposphere; on the other hand, the very high ratios that are typical of the hydrosphere may offer opportunities of detecting such effluents in the hydrosphere on the basis of tritium to krypton-85 ratios. Considerable uncertainties in the ratios of the effluents have, however, to be anticipated, arising from varying, and fluctuating, fractionation between the two nuclides in the release processes. (auth)

THERMAL EFFLUENTS MONITORING AND TRANSPORT

5618 (ATDL—75/17, pp 15-54) **Meteorological effects of the cooling towers at the Oak Ridge Gaseous Diffusion Plant. II. Predictions of fog occurrence and drift deposition.** Hanna, S.R. Sep 1975.

In 1974 annual report.

The frequency of occurrence of fogs and the rate of deposition of chromate due to emissions from the cooling towers at the Oak Ridge Gaseous Diffusion Plant are calculated. Observations of drift deposition agree fairly well with calculated values. A detailed summary of significant findings is given. (auth)

5619 (ATDL—75/17, pp 55-70) **Meteorological effects of the mechanical-draft cooling towers of the Oak Ridge Gaseous Diffusion Plant.** Hanna, S.R. Sep 1975.

In 1974 annual report.

The mechanical-draft cooling towers at the Oak Ridge Gaseous Diffusion Plant dissipate about 2000 MW of heat. Downwash occurs about 40 percent of the time, when wind speeds exceed about 3 m/sec. An elevated cloud forms about 10 percent of the time. The length of the visible plume, which is typically 100 or 200 m, is satisfactorily modeled if it is assumed that the plumes from all the cells in a cooling-tower bank combine. The calculation of fog concentration is complicated by the fact that the moisture is not inert but is taking part in the energy exchanges of a thermodynamic system. Calculations of drift deposition agree fairly well with observations. (auth)

5620 (ATDL—75/17, pp 91-109) **Plume rise from multiple sources.** Briggs, G.A. Sep 1975.

In 1974 annual report.

A simple enhancement factor for plume rise from multiple sources is proposed and tested against plume-rise observations. For bent-over buoyant plumes, this results in the recommendation that multiple-source rise be calculated as [(N + S)/(1 + S)]/sup 1/3/ times the single-source rise, Δh_1, where N is the number of sources and S = 6 (total width of source configuration/N/sup 1/3/ Δh_1)/sup 3/2/. For calm conditions a crude but simple method is suggested for predicting the height of plume merger and subsequent behavior which is based on the geometry and velocity variations of a single buoyant plume. Finally, it is suggested that large clusters of buoyant sources might occasionally give rise to concentrated vortices either within the source configuration or just downwind of it. (auth)

5621 (ATDL—75/17, pp 127-133) **Fog and drift deposition from evaporative cooling towers.** Hanna, S.R. Sep 1975.

In 1974 annual report.

Methods of determining fog and drift deposition due to emissions from evaporative cooling towers are reviewed and formulas suggested that can be used as a basis for calculations. The Gaussian plume formula is recommended for calculating fog concentrations from which visibility can be estimated. For drift droplets with diameters greater than 200 μm, deposition is calculated by ballistics methods, knowing the environmental wind speed and relative humidity and the vertical velocity of the plume and the droplet. Evaporation of the droplets is accounted for. Drift droplets with diameters less than 200 μm are assumed to be dispersed according to the Gaussian plume formula, with the plume tilted downward to account for the settling speed of the droplet. (auth)

5622 (ATDL—75/17, pp 169-179) **Research needs related to hydrometeorologic aspects of future energy production.** Hanna, S.R. Sep 1975.

In 1974 annual report.

Plans are being made to develop large power parks and energy centers which will dissipate several thousand megawatts of waste heat to the atmosphere. Characteristics of these energy centers are discussed and estimates of environmental impact are made. Research needs are outlined. (auth)

5623 (CONF-751119—1) **Environmental and safety considerations for a fossil fuel-fired potassium-steam binary vapor cycle.** Fraas, A.P.; Holcomb, R.S. (Oak Ridge National Lab., Tenn. (USA)). 1975. 37p. Dep. NTIS $4.50.

From Symposium on environment and energy conservation; Denver, Colorado, USA (3 Nov 1975).

Design studies indicate that superimposing a potassium vapor cycle on a conventional steam cycle should increase the thermal efficiency of a fossil fuel-fired plant to about 50 percent, thus reducing the fuel consumption by about 25 percent and the rejection of waste heat to the environment by about 33 percent. Systems have been designed for burning gas or oil in furnaces that would employ burners that recirculate flue gases to reduce NO/sub x/ release. High sulfur coal would be burned in a fluidized bed furnace fed with limestone or dolomite to react with the SO_2 in the combustion zone and reduce the emission of SO_2 by about 90 percent. Electrostatic precipitators operating at flue gas temperature of about 800°F (427°C) could be used to control the emission of particulates to a very low level. The reactive character of potassium dictates that careful attention be given to the design and construction of the system to insure that the safety of the plant is maintained. A novel design for the potassium condenser-steam generator has been evolved to minimize the energy release of a steam leak into the potassium. By employing this design along with the high standards of fabrication and the sensitive leak detection methods that have been developed for liquid metal systems in the nuclear power program, the probability of serious consequences from a leak should be kept very low. The worst accident from the standpoint of the public would be the release of most of the potassium inventory to the stack. Such an accident is unlikely since the combustion gas pressure in the furnace would be higher or nearly equal to the potassium pressure in the boiler, but to guard against this contingency a wet scrubber would be included at the base of the stack so that it could be activated in an emergency. (auth)

ENVIRONMENTAL SCIENCES, TERRESTRIAL

5624 (CONF-751064—1) **Analysis application of land-use data.** Voelker, A.H. (Oak Ridge National Lab., Tenn. (USA)). 1975. 19p. Dep. NTIS $4.50.

From Proceedings of American Society of Photogrammetry; Phoenix, Arizona, USA (26 Oct 1975).

The ever-broadening scope of planning requires improved techniques for gathering, manipulating, and displaying spatial information. Fortunately, the combination of high-altitude photography as a potential data source and computer-based geographical information systems as a means of achieving efficient data manipulation offer the planner powerful analysis capability. This paper demonstrates the utility of land-use data extracted from high-altitude photography in the development of a computerized land-use model. A technique is explained for synthesizing mapped land-use data categorized in the Anderson Classification System with other spatial variables to create an abstract index of land-use compatibility. The questions of resolution, accuracy, index validation, and index display are considered. Finally, some observations are made about the applicability of computer analysis using remote-sensor data. (auth)

BASIC STUDIES

5625 (BNWL—1929) **Interspecific associations of Peromyscus maniculatus, Perognathus parvus, and Spermophilus townsendi on the Arid Land Ecology Reserve examined by diet overlap and related data.** Johnson, M.K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1975. Contract E(45-1)-1830. 51p. Dep. NTIS $5.45.

Thesis.

Vegetational overlap of the diets of three species of rodents (Perognathus parvus, Peromyscus maniculatus, and Spermophilus townsendi) was examined during 1974 on the ALE (Arid Lands Ecology) Reserve in eastern Washington. Diet analysis results were compared with values of aboveground biomass of plant species on the study site in order to indicate food preferences of the animal species. The S. townsendi diet overlapped minimally with the diets of the other species. Its major food item was determined to be Poa sandbergii which constituted 49 percent of the relative density of stomach samples. More overlap was observed in the diets of P. parvus and P. maniculatus. Major food items included Bromus tectorum, Descurainia pinnata, and insect materials. Comparison of caloric needs of the species and the caloric supply in the environment suggest that none of the dietary items were limiting during the study period. (auth)

5626 (CONF-751057—1) **Assessing data needs and related criteria: discussion of environmental data.** Voelker, A.H. (Oak Ridge National Lab., Tenn. (USA)). 1975. 11p. Dep. NTIS $4.50.

From Meeting on environmental analysis techniques and procedures for siting utility systems; Madison, Wisconsin, USA (20 Oct 1975).

Data are of fundamental importance to the route selection process. Its selection and manipulation unfortunately is still as much art as science. However, some understanding of the nature of environmental data and its application in resource questions has appeared in recent years. The purpose of this discussion has been to enumerate some of these points. Data loses content through abstraction. All data contains error, and systematic procedures are required to reduce it. For reasons of economy and ease of interpretation, data should be reduced to an essential subset needed for a particular analysis. Unique scales best fit the various levels of siting analysis. Resolution of individual datum can limit the resolution of the analysis. Computers can be a significant tool to the planner if used properly in a cost-conscious way. (auth)

5627 (COO—2534-1) **Seismological investigation of crack formation in hydraulic rock fracturing experiments. Progress report, January 1, 1975—August 31, 1975.** Aki, K. (Massachusetts Inst. of Tech., Cambridge (USA)). Sep 1975. Contract E(11-1)-2534. 28p. Dep. NTIS $5.00.

A new seismic method of determining the location, size and orientation of hydrofractured cracks has been developed. The method uses the active devices such as explosion and vibroseis. The effect of heterogeneous earth medium on the seismogram is eliminated by taking the difference between two seismograms obtained in repeated experiments; one before and the other after the crack formation. Since the crack will act as a virtual seismic source for the differential seismograms at far-field, we can apply the conventional technique used for earthquake source mechanism studies to find the location, size and orientation of the crack. The differential seismogram at near-field will define the shadow zone which can be used most effectively for the determination of crack location. A computer program has been developed to calculate the seismic wave scattering by a crack for the case of incident P, SV, and SH waves. The program will play a fundamental role in the interpretation of the differential seismogram. (auth)

5628 (LA-UR—75-2136) **Rio Grande Rift: cenozoic continental rift tectonics.** Bridwell, R.J.; McGetchin, T.R.; Olsen, K.H.; Anderson, O.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 14p. (CONF-751151—1). Dep. NTIS $4.50.

From Symposium on the rift zones of the earth, Soviet Geophysics Committee of the Academy of Science; Irkutsk, USSR (Nov 1975).

The Rio Grande Rift is a system of elongate, echelon tectonic basins extending approximately 1000 km from New Mexico to Colorado. These basins are rift valleys bounded by normal faults and are located between vast, elevated regional uplifts. Basin-filling bolson sediments are approximately 3 km deep and range from 20 to 100 km wide. Tertiary volcanism began approximately 37 my in the San Juan and Datil—Mogollon Mountains. Regional extension began approximately 23 to 29 my. Early andesitic volcanism (approximately 26 to 20 my) was followed by bimodal basalt-rhyolitic volcanism approximately 14 my, which sharply accelerated approximately 5 my. Surface heat flow of the Rift is approximately 2 to 3 times that of adjacent stable regions. High electrical conductivity has been interpreted as shallow partial melt zones beneath the Rift. Regional seismicity occurs along the Rift with local magnitudes of 1.2 less than or equal to M_l less than or equal to 3.5, although M approximately equal to 6 events have historically occurred. Bouger gravity anomalies are generally interpreted as results of shallow basins although a deep pillow-shaped mantle intrusion has been interpreted from long wavelength anomalies in the southern Rift. Clearly, seismicity, high heat flow, high electrical conductivity, and recent volcanism indicate that the Rio Grande Rift is a region of current tectonic instability. Observations and inferences concerning the Rio Grande Rift are consistent with current tectonic models for early stages of the opening of ocean basins by a process involving thinning of the crust over a mantle upwarp.

5629 (ORNL-tr—4045) **Mining in the Hallstatt salt mine.** Morton, F. Translated by R.G. Mansfield from *Archaeol. Austriaca;* 2: 68-75(1949). 7p. Dep. NTIS $4.50.

Archaeological specimens found in prehistoric mines in the Hallstatt salt deposit, Austria, are described. (CH)

5630 (UCRL-Trans—10727) **Velocity of elastic waves at high pressures in the igneous and metamorphic rocks of various regions.** Bayuk, E.I.; Volarovich, M.P.; Skvortsova, L.S. Feb 1974. Translated from pp 127-137 of Tektonofizika i mekhanicheskie svoistva gornykh porod, Izdatel'stvo "Nauka", 1972. 16p. Dep. NTIS $4.50.

The elastic-wave velocities measured in rock specimens of the USSR at high pressures were used in investigations on tectonophysics and theoretical geophysics in the interpretation of deep seismic sounding (DSS) data in mining. For the upper part of the Earth's crust, to depths of 10 to 20 km, it is important to know the velocities at up to a few kilobars, for deep layers of the crust, including the Mohorovicic discontinuity, at up to 10 to 20 kbar, and for the upper mantle the velocities at still higher pressures. (auth)

5631 **Attempt to characterize certain organic and mineral substances by their stable isotope composition.** Bricout, J. (Institut de Recherches Appliquees aux Boissons, Creteil, France); Fontes, J.C.; Letolle, R.; Mariotti, A.; Merlivat, L. pp 359-372 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975). (In French)

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The determination of the relative abundance of various stable isotopes—deuterium, oxygen-18, carbon-13, nitrogen-15, sulphur- 34—can be used to characterize the origin of a water body and of an organic or mineral substance in the environment. This results from the discovery that isotopic fractioning by living organisms occurs. The stable isotope composition of any substance reflects, at least partly, the various stages of its formation. A number of examples supporting this hypothesis are given. The passage of water through plants, or alcoholic fermentation, substantially modifies the stable isotope composition of water. The assimilation of atmospheric carbon dioxide involves a reduction in the carbon-13 content which varies depending on the enzymatic mechanism of photosynthesis. The enzymatic reactions that cause the biosynthesis of various organic substances in higher plants are accompanied by partial exclusion of deuterium, an exclusion which is greater or smaller depending on the biosynthesis pathway followed. The bacterial reduction of sulphur compounds involves a high rate of isotopic fractioning. As a result, industrial sulphates obtained by oxidation of reduced sulphur associated with hydrocarbon deposits are depleted in ^{34}S in comparison with natural sulphates. Similarly, the authors have observed that nitrates produced by the plant biological cycle are rich in nitrogen-15 compared to synthesized nitrates. (auth)

5632 (UCRL-Trans—10916) **Dipole electroprofiling. Manual for geological mapping and mineral search and exploration.** Blokh, I.M. Apr 1975. Translated from pp 10-45 of Chapter I and selected excerpts from Dipol'noe elektroprofilirovanie, Gosgeoltekhizdat, Moscow, 1957. 68p. Dep. NTIS $5.50.

The principal features of the theory of dipole electroprofiling are a direct consequence of the general theory of the field of direct electric current within the ground. It is known that current passed into the ground produces a certain potential difference between any pair of points within the ground or on the ground surface. If this potential difference (ΔV) and the current passed into the ground (I) are measured, it is possible to calculate a quantity with the dimensions of specific resistance and depending on the geometric dimensions of the equipment as well as on the geo-electrical section of the Earth's crust at the place of the observations. This quantity is known as the apparent specific resistance and study of its distribution in a selected locality (or of the nature of the change in this distribution as the electrode separation is altered) provides material for geologic conclusions. Dipole electroprofiling provides an idea of the nature of the change in the apparent specific resistance along profiles, i.e., directions selected in the locality. In electroprofiling (including dipole electroprofiling) the distribution of the apparent specific resistance is studied. It is therefore necessary to establish methods of calculating this quantity. The methods of calculation are detailed. (auth)

5633 (ORNL-tr—4056) **Old Celtic mine in Hallstatt salt deposit.** von Hochstetter, F. Translated by R.G. Mansfield from *Mitt. Anthropol. Ges. Wien;* 11: 65-72(1881). 12p. Dep. NTIS $4.50.

Archaeological specimens found in prehistoric mines in the Hallstatt salt deposits, Austria, are described. (CH)

RADIOMETRIC TECHNIQUES

5634 **Ge(Li) spectrometric measurements of isotopic uranium ratios in soils treated with apatite-derived fertilizers.** Lindeken, C.L.; Coles, D.G.; Meadows, J.W. (Univ. of California, Livermore). pp 255-265 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

Soil samples collected in an agricultural region of the Sacramento-San Joaquin Delta in central California contained levels of uranium as high as 17 ppm. Isotopic uranium analysis, determined by mass spectrometry, showed $^{235}U/^{238}U$ ratios of 7.1×10^{-3}, typical of natural uranium. However, the ^{238}U content inferred from gamma counting of the ^{226}Ra daughters disclosed marked disequilibrium in the ^{238}U decay series. The elevated levels of uranium are attributed to its presence in ammonium phosphate fertilizer produced from apatite [$CaF_2Ca_3(PO_4)_2$]. The ^{238}U daughter disequilibrium is due to removal of ^{226}Ra by coprecipitation with $CaSO_4$ during conversion of the raw material to phosphoric acid with sulphuric acid. A more direct method for ^{238}U measurement based on detection of the 63-keV transition gamma of ^{234}Th and using Ge(Li) gamma spectrometry is described. This method is independent of ^{226}Ra daughters and can detect ^{238}U down to about 0.1 $\mu g/g$ in soils. A comparison with ^{238}U measurements using mass spectrometry shows agreement within +- 10 percent. (auth)

CHEMICALS MONITORING AND TRANSPORT

5635 **Isotope ratios of lead as pollutant source indicators.** Chow, T.J.; Snyder, C.B.; Earl, J.L. (Univ. of California, San Diego, La Jolla). pp 95-108 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

Each lead ore deposit has its characteristic isotope ratios which are fixed during mineral ore genesis, and this unique property can be used to indicate the source of lead pollutants in the environment. The world production of primary lead is tabulated, and the geochemical significances of lead isotope ratios are discussed. The manufacture of lead alkyl additives for gasoline, which is the major source of lead pollutants, utilizes about 10 percent of the world annual consumption of lead. The isotope ratios of lead in gasoline, aerosols, soils and plants are correlated. Lead additives in various brands of gasoline sold in one region do not have the same isotope ratios. Regional variations in isotope ratios of lead additives were observed. This reflects the fact that petroleum refineries obtained the additives from various lead alkyl manufacturers which utilized lead from different mining districts. A definite changing trend of isotope ratios of lead pollutants in the San Diego, California (USA), area was detected. The lead shows a gradual increase in its radiogenic components during the past decade. This trend can be explained by the change of lead sources used by the additive manufacturers: Lead isotope ratios of the mid-1960's gasoline additives in the United States of America reflected those of less radiogenic leads imported from Canada, Australia, Peru and Mexico. Since then, the U. S. lead production has doubled—mainly from the Missouri district of highly radiogenic lead. Meanwhile, there has been a decrease in total lead imports. These combined effects result in changes in isotope ratios, from the less to more radiogenic, of the pooled lead. (auth)

5636 **Problems and potentialities of stable isotopes as tracers for studying pollutant behavior under field conditions.** Matwiyoff, N.A.; Cowan, G.A.; Ott, D.G.; McInteer, B.B. (Los Alamos Scientific Lab., NM). pp 305-325 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The separated stable isotopes of carbon (^{12}C, ^{13}C), oxygen (^{16}O, ^{17}O, ^{18}O), and nitrogen (^{14}N, ^{15}N) (the ICONs) have been available in limited quantities for many years. These non-radioactive, naturally occurring forms of the elements are the basic building blocks of natural compounds and of pollutants, and their great potential utility for tracer studies has long been recognized. However,the separated isotopes in the required chemical forms have been relatively expensive and the analytical instrumentation necessary for their detection and assay has been expensive to acquire and difficult to maintain. Recently this situation has begun to change rapidly and, in this paper, we review the problems and potentialities of stable isotopes as tracers for studying pollutant behaviour under field conditions. In this review, the radically changed situation with respect to increased supplies of the ICONs at low cost will be discussed against the backdrop of the continued high cost of certain isotopically labelled compounds and of analyses. Prospects for improvements in the latter areas will be explored in the context of the experience accumulated at the Los Alamos Scientific Laboratory in ICONs research and development activities directed toward ICONs production, synthesis of labelled compounds, and analytical techniques for ICONs. The potential and actual applications of ICONs for studying pollutant behaviour under field conditions will be surveyed with emphasis on: the use of ^{15}N and ^{14}N (depleted in ^{15}N) for tracing N tagged fertilizer; the use of mass spectrometry and nuclear magnetic resonance spectroscopy for studying the distribution and fate of ^{13}C and ^{15}N tagged pesticides in the biosphere; and the use of tagged methane as a tracer for transport and dispersion studies in the atmosphere. (auth)

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

5637 (AAEC/E—366) **Rum Jungle environmental studies. Summary report.** Watson, G.M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sep 1975. 28p. Dep. NTIS (US Sales Only) $5.00.

Sources of pollution at the Rum Jungle uranium mine were identified and their relative importance assessed. Observations were made on seasonal variations and differences were noted between the dispersion patterns of several metals of interest. The geographical extent of chemical and biological pollution and radioactivity was examined. Some understanding of the basic mechanisms involved in continuing pollution was obtained and an attempt was made to determine the fate of heavy metals. (auth)

5638 (BNWL-B—368) **Recommendations concerning the computation and reporting of counting statistics for the Nevada Applied Ecology Group.** Gilbert, R.O. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-1830. 75p. Dep. NTIS $5.45.

5639 (BNWL-SA—5451) **Radionuclides in Canada goose eggs.** Rickard, W.H.; Sweany, H.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 12p. (CONF-750985—1). Dep. NTIS $4.50.

From 15. Hanford life sciences symposium; Richland, Washington, USA (25 Sep 1975).

Low levels of radionuclides were measured in Canada goose eggs taken from deserted nests from Columbia River islands on the Energy Research and Development Administration's Hanford Reservation. Potassium-40, a naturally occurring radionuclide, was

the most abundant radionuclide measured in egg contents and egg shell. Strontium190 was incorporated into egg shells and cesium-137 into inner egg contents. Manganese-54, cobalt-60, and zinc-65 were more abundant in inner egg contents than in egg shell. Cerium-144 was detected in egg shell but not in inner shell. (auth)

5640 (BNWL-SA—5494(Pt.1)) **Monitoring and characterization of radionuclide transport in the hydrogeologic system.** Phillips, S.J.; Raymond, J.R. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 23p. (CONF-750967—15). Dep. NTIS $4.25.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

The groundwater monitoring program provides information and data on groundwater quality required to evaluate the impact of waste disposal practices on the Hanford Reservation. The program includes: collection and analysis of groundwater samples on a routine basis; data processing, analysis and reporting; design, construction and maintenance of well sampling structures; and design and implementation of supporting research studies. Within the overall framework of the Groundwater Monitoring Program, the 300 Area and Wye Burial Ground Characterization Program was initiated to evaluate transport of radionuclides in the partially saturated zone above the water table and to provide site characterization at solid waste burial locations on the Reservation. Methods for collecting and analyzing program data include geophysical exploration by ground penetrating radar, refraction and reflection acoustics, magnetics, and metal detection; stratigraphic investigations by drilling and sample collection techniques; evaluation of transport phenomena by in situ psychrometric and gamma-neutron techniques; laboratory characterization of fluid and vapor transport-controlling mechanisms; and evaluation of biological radionuclide transport by organisms inhabiting contaminated areas. (auth)

5641 (BNWL-SA—5494(Pt.2)) **Monitoring and characterization of radionuclide transport in the hydrogeologic system.** Phillips, S.J.; Raymond, J.R. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 84p. (CONF-750967—16). Dep. NTIS $5.00.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

Historical records pertaining to the 300 North and Wye Burial Grounds at the Hanford Reservation were reviewed as a prerequisite to determining programs for land reclamation. All available historical documents, agency communications, and engineering drawings related to the study areas were located, reviewed, and analyzed. An inventory of recorded location, type, and quantity of radionuclides and associated materials in each burial ground was completed and distributed to cooperating investigators. A geophysical survey of the 300 North Burial Ground was conducted as a basis for detecting the composition, size, distribution, and depth of buried objects and characterizing the sediments in which they are buried. Acoustic, radar, magnetic, and metal detection surveys were completed and their applicability evaluated; drilling techniques and equipment for recovering and characterizing sediments and radioactive contaminated material were developed. Drilling will also determine the amount and dimensional extent of radionuclide migration; sediment-fluid interaction and fluid migration through the unsaturated zone at the 300 North Burial Ground were characterized. A study to determine biological transport of radionuclides at the Wye Burial Ground was also initiated. This study involved a preliminary survey of present flora and fauna inhabiting the Wye Burial Ground site. Plant tissue was chemically and radiochemically analyzed to determine radionuclide migration and possible dose effects and population dynamics of burrowing animals that could potentially be exposed to buried waste materials were investigated. (CH)

5642 (BNWL-SA—5505) **Statistical design and analysis of environmental studies for plutonium and other transuranics at NAEG "safety-shot" sites.** Gilbert, R.O.; Eberhardt, L.L.; Fowler, E.B.; Romney, E.M.; Essington, E.H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1975. Contract AT(45-1)-1830. 13p. (CONF-751105—6). Dep. NTIS $4.00.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

This paper is centered around the use of stratified random sampling for estimating the total amount (inventory) of $^{239-240}$Pu and uranium in surface soil at ten "safety-shot" sites on the Nevada Test Site (NTS) and Tonopah Test Range (TTR) that are currently being studied by the Nevada Applied Ecology Group (NAEG). The use of stratified random sampling has resulted in estimates of inventory at these desert study sites that have smaller standard errors than would have been the case had simple random sampling (no stratification) been used. Estimates of inventory are given for ^{235}U, ^{238}U, and $^{239-240}$Pu in soil at A Site of Area 11 on the NTS. Other results presented include average concentrations of one or more of these isotopes in soil and vegetation and in soil profile samples at depths to 25 cm. The regression relationship between soil and vegetation concentrations of ^{235}U and ^{238}U at adjacent sampling locations is also examined using three different models. The applicability of stratified random sampling to the estimation of concentration contours of $^{239-240}$Pu in surface soil using computer algorithms is also investigated. Estimates of such contours are obtained using several different methods. The planning of field sampling plans for estimating inventory and distribution is discussed. (auth)

5643 (CONF-751105—4) **Physical and chemical characteristics of plutonium in existing contaminated soils and sediments.** Tamura, T. (Oak Ridge National Lab., Tenn. (USA)). 1975. 19p. (SM—199/52). Dep. NTIS $4.00.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

Plutonium from three sites was studied to provide information necessary in understanding its behavior and fate under prevailing conditions. Plutonium in soils from the Nevada Test Site (NTS) was predominantly associated (50 to 75 percent) with the coarse silt (53 to 20 μm) fraction. The plutonium in samples from Oak Ridge National Laboratory (ORNL) and Mound Laboratory (ML) was predominantly in the clay size (less than 2 μm). The solubility in citric acid was about 20 to 25 percent in the ORNL sample and 40 to 50 percent in the ML sample. Density gradient segregation of the clay size fraction of the ML sample showed the activity distribution to be directly related to the weight of the recovered fraction with enhanced contribution by the very light organic fraction. Approximately 71 percent was found in the 2.3 to 2.4 g/cm^3 fraction which contained 65 weight percent of the clay and 16 percent in the less than 1.8 g/cm^3 fraction (organic fraction) which contained 6 percent of the weight fraction. (auth)

5644 (DPSPU—75-30-8) **oSurvey for radioactivity in a swamp.** Johnson, J.E. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Sep 1975. Contract AT(07-2)-1. 11p. (CONF-750967—4). Dep. NTIS $4.00.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

An estimated 25 curies of cesium-137 and less than 1 curie of cobalt-60 were deposited in an offsite swamp below the Savannah River Plant by effluents to site streams during periods of river flooding. Aerial surveys were effective in defining the deposited radioactivity. Ground surveys with portable gamma scintillometers and thermoluminescent dosimeters indicated dose rates generally below 60 μR/hr with a maximum of 120 μR/hr. Soil samples contained ^{137}Cs ranging from less than 1 to 525 pCi/g in the top 7.5 cm. Vegetation contained from 1 to 235 pCi/g, and wildlife ranged from less than 1 to 15 pCi/g in edible tissue. A comprehensive ground survey on a three-meter centered grid pattern was conducted on 43 acres in the area of higher readings. No restrictions on use of the swamp are warranted. The swamp will be monitored annually to evaluate possible redistribution of the ^{137}Cs. (auth)

5645 (TID—26872) **Annual report, 1973—1974.** (Nevada Univ., Reno (USA). Desert Research Inst.). 1974. 167p. Dep. NTIS $11.50.

Separate abstracts were prepared for two sections of this report. Both sections have been announced in ERDA Research Abstracts, and one has been announced in Nuclear Science Abstracts. (CH)

5646 (TID—26872, pp 44-47) **Hydrology of Nevada test site and Dribble test site, Mississippi.** Maxey, G.B.; Fenske, P.R. 1974. In Annual report, 1973—1974.

A computer-simulated water table map of the Nevada Test Site and environs was generated. Methods were developed for calculating the rate of infill of ground water in rubble chimneys formed by the detonation of an underground nuclear explosion. The optimum location for drilling test wells outside a rubble chimney to monitor the transport of radioactivity in ground water in the area was investigated. Radionuclide migration in ground water and salt water aquifers at the Dribble Site, Mississippi, was investigated. Radioactive wastes from the detonation of a nuclear explosive device at a depth of 2700 ft in a salt mine were deposited in a deep salt water zone at the Dribble Site. (CH)

5647 (UCRL—77318) **Evaluation of the use of sludge containing plutonium as a soil conditioner for food crops.** Myers, D.S.; Silver, W.J.; Coles, D.G.; Lamson, K.C.; McIntyre, D.R.; Mendoza, B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Sep 1975. 19p. (SM—199/42; CONF-751105—3). Dep. NTIS $4.50.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

An experiment was conducted to assess the potential hazard associated with the use of sludge containing plutonium as a soil conditioner for food crops. Conditions were chosen that would maximize exposure to the ^{239}Pu in the sludge through resuspension and in plant content and thus approximated the maximum potential hazards due to the inhalation and ingestion pathways. The estimated 50-year radiation doses to the pulmonary region of the lung, bone, and liver based on the results of the inhalation experiment are 6×10^{-4} rem, 1.2×10^{-2} rem, and 0.55×10^{-4} rem, respectively. Similarly, the 50-year radiation doses attributable to ingestion of the sludge-grown vegetables were 2.2×10^{-5} rem to the bone and 1.5×10^{-5} rem to the liver. Thus, the inhalation pathway is the more critical of the two. The maximum permissible annual doses to the lungs, bone, and the liver for a member of the general public are 1.5, 3.0, and 1.5 rem, respectively. Thus, the maximum credible 50-year lung, bone, and liver dose commitments associated with the use of the ^{239}Pu-contaminated sludge as a soil conditioner are approximately 4.0×10^{-2} percent of the annual maximum permissible dose. Under more realistic exposure circumstances, one might expect less drying of the sludge, less resuspension of dust and flying dirt before and during rototilling, and a much smaller sludge vegetable consumption rate. The conservative assumptions made in this analysis tend to assure that actual radiation doses would be even less than those calculated. (auth)

5648 Isotopic ratios f iodine and other radionuclides as nuclear power pollution indicators. Brauer, F.P.; Ballou, N.E. (Battelle-Pacific Northwest Labs., Richalnd, WA). pp 215-229 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The determination of isotope ratios in addition to radionuclide concentrations is useful in the identification and tracing of radioactive pollutant sources. Methods have been developed for measurement of $^{58}Co/^{60}Co$, $^{134}Cs/^{137}Cs$, $^{129}I/^{127}I$ and other radionuclide effluent isotope ratios at levels much below those required for radiation protection. Measurements of $^{58}Co/^{60}Co$, $^{134}Cs/^{137}Cs$, $^{135}Cs/^{137}Cs$ and $^{129}I/^{127}I$ in environmental samples have demonstrated their application to the detection of nuclear plant effluents. Increased $^{129}I/^{127}I$ ratios were observed in nuclear fuel separations facility environs at levels much below radiation protection standards. The pathways in the transfer of atmospheric ^{131}I to food materials has been studied by means of $^{129}I/^{127}I$ analyses of environmental samples. Vegetation absorption of atmospheric iodine was found to be significant. The $^{129}I/^{127}I$ ratio was observed to decrease in the pathway from the atmosphere to food. Examples of the use of ^{129}I analysis for environmental studies are presented. (auth)

5649 (ERDA-tr—67) **Conclusions drawn from study of migration of fission products.** Frejacques, C.; Blain, C.; Devillers, C.; Hagemann, R.; Ruffenach, J.C. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Div. de Chimie). 1975. Translation of SM—204/24. 25p. Dep. NTIS $4.25.

The Oklo fossil reactor is especially interesting and so far unique in the study of migrations of the uranium fission products after an exceptionally long cooling and storage time amounting to 1.8 billion years. The specimens studied are located along a drilling core which passes through a reaction zone. Panoramic analysis by mass spark spectrometry allows qualitatively displaying the curve of fission yields of the different isotopes and observation of abnormalities connected in the beginning with some of them: alkalines, iodine, molybdenum, alkaline-earths. The behavior of certain special elements has been specified by chemical and isotopic analyses. It is shown that the thorium formed by decay of ^{240}Pu and ^{238}U has remained linked to the uranium. The same is true for neodymium, samarium and gadolinium. The majority of the bismuth is also found to be formed by decay of ^{241}Pu and ^{237}U. The majority of the Ru has remained in situ, and a deficit close to 30 percent may be observed in some samples with a part of this attributed to the migration of the technetium 99. Analysis of krypton and xenon shows that the greatest part of these gases has disappeared and that this disappearance began to occur during the nuclear reaction. The magnitude of the storage problem for radioactive wastes produced in nuclear reactors gives an especial interest which is up until this point still unique in the lessons that can be drawn from study of the migration of fission products in the Oklo fossil reactor. (auth)

5650 (BNWL-tr—152) **Contamination of soils. Part 2. Behavior of radioactive ions in unsaturated soils after water disposal into a limited surface.** Rancom, D. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). 7 Oct 1975. Translation by L. Appleby of CEA-R—3635(2). 42p. Dep. NTIS $5.00.

The behavior of water in unsaturated soils after disposal into a limited surface was studied. Results are reported from a study in situ of the contamination of unsaturated soils after discharge into a limited surface, the measurement of the evolution of wetness in the soils being completed by measurement of the movement of radioactive ions in solution in the water. As most of the contaminating elements are more or less retained by the soil constituents, ^{131}I was chosen as the type of element loosely retained and ^{85}Sr was chosen as the element well retained. (CH)

SOIL

5651 Radioisotope ratios in characterizing the movement of different physical and chemical species through natural soils. Robertson, D.E.; Perkins, R.W. (Battelle-Pacific Northwest Labs., Richland, WA). pp 123-131 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

Physiochemical characterization studies of reactor effluent water radionuclides at the Hanford N-Reactor are providing important information describing the mobility of radionuclides in freshwater environments. At N-Reactor, cooling water containing a wide spectrum of radionuclides in various physicochemical forms is discharged to a seepage trench located near the reactor. The effluent water migrates through a soil bank between the trench and the Columbia River, and a portion of the water emerges as seepage springs along the bank of the Columbia River near the reactor. The mobility of effluent water radionuclides during transport through the soil is greatly dependent upon the physicochemical forms of the radionuclides. Radionuclides in particulate and cationic forms are nearly quantitatively retained in the soil bank by sorption onto mineral phases; whereas, radionuclides in anionic and soluble nonionic forms are relatively mobile and are retained by the soil to a much lesser degree. Several radionuclides such as ^{60}Co, $^{103-106}Ru$ and $^{122-124-125}Sb$ are present in reactor effluent water partitioned among particulate, cationic, anionic and nonionic species. However, as these radionuclides migrate through the soil bank their particulate and cationic forms are retained, and predominantly anionic and nonionic forms emerged in the seepage springs. Studies of the behaviour of these radionuclides are providing data for assessing present rad-waste treatment processes and in improving future processes for reducing environmental releases of radionuclides from nuclear installations. (auth)

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

5652 (COO—3011-5) **Occurrence of ^{137}Cs in the biosphere evaluated with environmental and metabolic studies.** Haesaenen, E. (Helsinki Univ. (Finland). Dept. of Radiochemistry). May 1972. Contract E(11-1)-3011. 119p. Dep. NTIS $6.50.

This work forms a part of the fall-out studies carried out in the Department of Radiochemistry, University of Helsinki. Its main emphasis has been on the γ-spectrometric determination of the ^{137}Cs-levels and changes herein in different environmental samples and in man after the second nuclear testing period in 1961—1962. Special attention has been paid to the aquatic foodchains of ^{137}Cs, to the foodchain reindeer-lichen-man, and to the biological half-life of ^{137}Cs in man and in certain fish species. (auth)

SITE RESOURCE AND USE STUDIES

5653 (COO—2307-9) **Biological/environmental relationships in desert ecosystems of the Nevada test site. Progress report, February 1, 1975—January 31, 1976.** Beatley, J.C. (Cincinnati Univ., Ohio (USA). Dept. of Biological Sciences). 1975. Contract E(11-1)-2307. 4p. Dep. NTIS $4.50.

Progress is reported on the compilation of a list of vascular flora of the Nevada Test Site during 1975. No technical data are included. (CH)

5654 (TID—26912) **Geology, physical properties, and surface effects at Discus thrower site, Yucca Flat, Nevada Test Site.** Carr, W.J.; Miller, C.H.; Dodge, H.W. Jr. (Alliance for Engineering in Medicine and Biology, Chevy Chase, Md. (USA)). 1975. 135p. Dep. NTIS $7.00.

Geologic studies in connection with Project Discus Thrower have furnished detailed stratigraphic and structural information about northwestern Yucca Flat, Nevada Test Site. The Paleozoic rocks consist of a lower carbonate sequence, argillite of the Eleana

Formation, and an upper carbonate sequence. The distribution of these rocks suggests that both top and bottom of the Eleana are structural contacts, probably thrusts or reverse faults. The overlying tuff includes several units recognized in the subsurface, such as the Fraction Tuff and tuff of Redrock Valley. Other units recognized include bedded tuff associated with the Grouse Canyon Member of Belted Range Tuff, and the Rainier Mesa and Ammonia Tanks Members of the Timber Mountain Tuff. The Timber Mountain and Grouse Canyon are extensively altered to montmorillonite (a swelling clay), possibly as a result of ponding of alkaline water. The overlying alluvium locally contains at the base a clayey, tuffaceous sandstone. (auth)

5655 (UCRL—51803) **Discussion of sites recommended as potential natural landmarks in the Arctic Lowland, northern Alaska.** Koranda, J.J.; Evans, C.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Apr 1975. Contract W-7405-Eng-48. 189p. Dep. NTIS $7.60.

ENVIRONMENTAL SCIENCES, AQUATIC

5656 **Nitrogen-15 studies on identifying fertilizer excess in environmental systems.** Freyer, H.D.; Aly, A.I.M. (Nuclear Research Center, Juelich, Ger.). pp 21-33 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The feasibility of identifying fertilizer excesses in surface and ground waters on the basis of variations in the isotope ratio of nitrogen has been studied. The isotope ratio of the commonly used ammonium and nitrate fertilizers is similar to that of atmospheric nitrogen. These ratios are shifted when fertilizers are added to the soil. In the soil, fertilizer ammonium is oxidized and the nitrate formed is reduced in the heavy isotope. The fractionation factors are calculated. This artificially added nitrate becomes mixed with natural nitrate which, in general, is enriched in the heavy isotope. Only 50 percent (or even less) of the nitrate formed may stem from the added fertilizer. The mixing ratios are time-dependent, and different for various types and conditions of soil. In spite of this complexity, information on this isotope process should be obtainable, if the isotope ratios of artificial and natural nitrate, respectively, are substantially different. Surface waters, in general, show no significant correlation between nitrate content and isotope ratio due to additions of sewage waters. Some data on ground waters from agricultural areas, however, where the nitrate content apparently resulted from fertilizers, gave a negative correlation of lower isotope ratios with higher nitrate contents. An inverse correlation was found in the isotope ratios of nitrate in untouched surface waters, and they even reflect the composition of the total soil nitrogen. (auth)

BASIC STUDIES

5657 (AECL—5041/1) **Hydrological studies on a small basin on the Canadian shield. Volume I. A final summary of the Perch Lake evaporation study, 1965—1974.** Barry, P.J. (ed.). (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Sep 1975. 388p. Dep. NTIS (US Sales Only) $11.75. AECL $20.00 per set.

The original purpose of the Study was to evaluate methods of estimating evaporation from a small lake. However, by the end of the International Hydrological Decade on 31 December 1974 one other major objective had been added: to evaluate methods of estimating the sub-surface water flow into and out of the lake with particular emphasis on the evaluation of so-called nuclear methods. At the same time, it became increasingly interesting to find out more about the biological, physical, chemical, and geological properties of the lake and its setting. The combined results of these studies have been collected together to present in this single volume a summary of what is known about one small, but by no means atypical, lake on the Canadian Shield. (auth)

5658 (BNL—20665) **Controllable automated environmental data acquisition and monitoring system.** Dimmler, D.G.; Greenlaw, N.; Rankowitz, S. (Brookhaven National Lab., Upton, N.Y. (USA)). Nov 1975. 27p. (CONF-751116—13). Dep. NTIS $5.00.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

A real-time data acquisition and monitoring system was developed for coastal oceanographic parameter measurements. This system continuously measures profiles of temperature, conductivity, current velocity and direction as a function of depth at a number of fixed off-shore locations. The data acquisition, monitoring and control system features make this system generally suitable for unattended area monitoring applications. (auth)

5659 (CONF-750642—1) **Survey of fishes from Barrio Islote on the north coast of Puerto Rico.** Kimmel, J.J. (Puerto Rico Nuclear Center, Mayaguez). 1975. 38p. Dep. NTIS $5.00.

From American Society of Ichthyologists and Herpetologists; Williamsburg, Virginia, USA (8 Jun 1975).

5660 (UCRL—51950) **Survey of current environmental research on San Francisco Bay and Delta waters.** Ritschard, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Oct 1975. Contract W-7405-Eng-48. 39p. Dep. NTIS $4.00.

A survey of current environmental research on the San Francisco Bay and Delta waters was conducted. Included in the report are the major federal and state agencies, academic institutions, consulting firms, and interested groups that have ongoing research programs. Information from each group is summarized into the following categories: projects, their goals, type of data collected, years of the study, funding agency, and computer capability. (auth)

5661 **Factors affecting the contribution by epiphytic algae to the primary productivity of an oligotrophic freshwater lake.** Sheldon, R.B.; Boylen, C.W. (Rensselaer Polytechnic Inst., Troy, NY). *Appl. Microbiol.*; 30: No. 4, 657-667(Oct 1975).

A diatom-dominated population of epiphytic algae was studied in an oligotrophic lake to determine the factors which limit epiphyte growth and to measure their contribution to primary productivity. Algae were collected from plants growing at four sites in Lake George, N. Y., during the spring, summer, and fall of 1974. Samples were taken from 3m, corresponding to the depth at which macrophytes were most productive. Algae exhibited an optimum temperature for $H^{14}CO_3^-$ uptake at 30 C, although the summer littoral lake temperature ranged from 18 to 25 C. Light saturation occurred at an intensity of 8,608 lux, approximating the environmental intensity at the depth from which algae were taken. Epiphytes exhibited their maximum photosynthetic capacity of 0.6 mg of carbon fixed/m^2 of macrophyte surface area per h in the early afternoon in mid-August. They assimilated approximately 5 percent as much inorganic carbon as the macrophytes from which they were taken. Epiphyte population densities followed the seasonal growth patterns of the macrophytes, with maximal leaf colonization remaining essentially constant relative to the leaf position on the plant. There was little change in density between sampling sites at any given time. Productivities of epiphytes from bottom leaves were 10-fold greater than those of epiphytes from top leaves. Addition of PO_4^{-3}, NO_3^-, NH_3, Si, and SO_4^{-2} had no stimulatory effect on photosynthesis. Addition of HCO_3^- stimulated photosynthesis greater than 30 percent, suggesting that carbon may be a limiting nutrient for epiphytic algae in Lake George. (auth)

RADIOMETRIC TECHNIQUES

5662 **$^{14}C/^{12}C$ ratios as tracers of urban pollution.** Baxter, M.S. (Univ. of Glasgow); Harkness, D.D. pp 135-141 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

Since fossil carbon is ^{14}C-free environmental materials influenced by industrial activity have $^{14}C/^{12}C$ ratios which are measurably depressed below natural values. In this study $^{14}C/^{12}C$ ratios in samples from an industrial region are compared with those in relatively unpolluted materials. It is shown that artificial sedimentation rates in the coastal sewage dumping area off the West of Scotland are an order of magnitude higher than the natural rate for this region. The $^{14}C/^{12}C$ ratio in the normal industrial atmosphere shows that up to 20 percent of the total carbon dioxide content is derived from local combustion of fossil fuels. This may be compared with a circa 6 percent contribution on a worldwide basis. (auth)

5663 **Cycling of organic carbon in the ocean: use of naturally occurring radiocarbon as a long and short term tracer.** Williams, P.M.; Linick, T.W. (Univ. of California, San Diego, La Jolla). pp 153-167 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The natural radiocarbon activities of surface, bathypelagic and benthic marine organisms have been measured for samples collected from the north central, north eastern and central equatorial Pacific Ocean and from the Ross Sea in Antarctica. These measurements show that 1961-1962 bomb-carbon-14 has been incorporated into the bathypelagic specimens in varying amounts. Thus, pollutants introduced into surface waters of the oceans may be removed more or less rapidly from the euphotic zone into the deep water depending upon particular food chain mechanisms. These results are discussed in relation to the cycling of dissolved organic carbon, the flux of particulate organic carbon through the seawater column into the sediments, and to the oxidation rates of organic matter in the deep sea. (auth)

5664 **Use of environmental isotopes to investigate the interconnections between the Reno River and groundwater (Northern Italy).** Carlin, F. (CNEN, Rome); Magri, G.; Cervellati, A.; Gonfiantini, R. pp 179-194 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

This research is part of the investigations carried out to assess the environmental impact of the Brasimone site in the upper reaches of the Reno River, where a nuclear research plant is under construction. This plant might imply a risk of contamination of the Reno River water by radioactive wastes. Environmental isotope techniques were used to study the interconnections between the Reno River and groundwater and qualitatively to define the flow dynamics between the surface waters and groundwater in the area of Bologna. The Reno River flows across an aquifer consisting of an irregular succession of alluvial beds of sandy gravel, sands and clayey or sandy silts of varying thicknesses. At the two pumping stations of Borgo Panigale and Tiro a Segno, the tritium and ^{14}C contents of the groundwater regularly decrease with increasing distance from the Reno River. This indicates that there is a contribution of recent water recharged from the river, and that such a contribution decreases as the distance from the river increases. For equal distances, the river contribution is higher in Borgo Panigale than in Tiro a Segno. At the pumping stations of San Vitale di Reno, only recently put into operation and at a distance from the river greater than that of the other two stations, there is no indication of recharge of recent river water. Stable isotopes also show a slight variation with the distance from the river, in agreement with the fact that deep groundwater is a mixture of variable proportions of two components, one of them originating from the river. All these results were possible to achieve only by means of environmental isotope techniques. (auth)

CHEMICALS MONITORING AND TRANSPORT

5665 (BNL—20757) **Meadow/Marsh systems as sewage treatment plants.** Small, M.M. (Brookhaven National Lab., Upton, N.Y. (USA)). Nov 1975. 39p. Dep. NTIS $4.00.

All parameters of both the Marsh/Pond and the Meadow/Marsh/Pond systems which have been measured to date indicate that both systems produce water which is suitable for groundwater recharge or other reuse without a public health hazard. It is noted that this discharged water can be made to satisfy both effluent and drinking water standards where they have been applied. On the basis of investigations to date both systems can be recommended for use as sewage treatment plants, water producers and farms for sewage loads between 10,000 and 1,000,000 gallons per day, i.e. for human populations between 100 and 10,000. Although some advantages are beginning to appear that favor one system over the other there is no clear choice at present. It is expected that land availability and its terrain will be principal determinants in a choice based on less first cost: crop value will be the principal element to determine the system with the lower operating cost: assuming as expected, that both systems continue to produce water of comparable, acceptable quality. (auth)

5666 (BNL—20778) **Hydrogen sulfide in bottom water near a sewage sludge dumping site.** Barvenik, F.W.; Hill, B.W.; Aneja, V.P.; Felder, R.M. (Brookhaven National Lab., Upton, N.Y. (USA)). Oct 1975. 29p. Dep. NTIS $4.00.

An attempt was made to detect volatile sulfur compounds in bottom water at a sewage sludge dumping site in the apex of the New York bight. Water from two meters above bottom was pumped on board ship and then through a gas-liquid contactor. Volatile compounds transferred to the gas phase were passed to a gas chromatograph sensitive to sulfur compounds. Significant peaks were found for hydrogen sulfide but peaks for other sulfur compounds were not clearly evident. Assuming an equilibrium distribution of H_2S between gas and liquid phases in the contactor, the concentration of total sulfide in solution in the bottom water was estimated to be 0.03 to 0.08 μM. The bottom water was found to be partially depleted of dissolved oxygen and contained a small population of sulfate reducers (Desulfovibrio desulfuricans). Additional experiments designed to permit further characterization of the marine experiment in the vicinity of sewage sludge dumping sites insofar as sulfur compounds are concerned are suggested. (auth)

5667 (CONF-751216—1) **Integrated waste management systems: onsite MIUS applications.** Rothenberg, J.H.; Mixon, W.R.; Boegly, W.J. Jr. (Oak Ridge National Lab., Tenn. (USA)). 1975. 27p. Dep. NTIS $4.50.

From Proceedings of energy conservation; Ft. Lauderdale, Florida, USA (1 Dec 1975).

The Department of Housing and Urban Development (HUD) is conducting the Modular Integrated Utility System (MIUS) Program devoted to development and demonstration of the technical, economic, and institutional advantages of integrating the systems for providing all or several of the utility services for a community. Possible utility services include the provision of electric power, space heating and cooling, potable water, fire protection water, and liquid and solid waste treatment and disposal. The objective of the MIUS concept is to provide the desired utility services in a way that is consistent with reduction in the use of critical natural resources, protection of the environment, and minimization of cost. A MIUS might be sized to accommodate several hundred or a few thousand multifamily dwelling units, nearby single-family housing, and associated commercial facilities. It uses a complex of small, on-site combined package plants, each sized to meet demands of the development served. The MIUS is modular in that it can be installed near appropriate users in phase with the actual demands of community development or redevelopment. It uses an integrated systems approach whereby some resource requirements of one service are met by utilizing the effluent of another. For example, heat rejected from electrical generation might be used for residential space heating, and the effluent from liquid waste treatment might be used for fire protection and/or cooling tower water. Each of the major utility subsystems of MIUS are examined with respect to the potential for integration with other subsystems and the advantages resulting from such integration. The conclusions presented represent a current summary of results from evaluation studies of major components and subsystems applicable to MIUS, systems analyses comparing MIUS to conventional utilities serving identical consumer models, and assessments of impacts from application of the MIUS concept. (auth)

5668 (SAND—75-0518) **Heavy metals in estuarine benthic organisms and sediments: data and model.** Wayland, J.R.; Baker, J.H.; Ivy, J.T.; Bedinger, C.A. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 25p. Dep. NTIS $4.00.

Coastal industrial development and subsequent heavy metal release requires an understanding of the environmental contamination that can result. A dynamic model has been developed in close association with a detailed environmental surveillance program of an estuarine ecosystem. The program and model trace the heavy metals from release into the water column and subsequent interactions with the air—water interface, pelagic zone, and sediments. The program and model also account for the interaction of phytoplankton, zooplankton, benthic organisms, and predators. The results of the calculations are compared to measurements taken in an estuarine ecosystem over a two-year period. (auth)

5669 (SRO—825-1) **Report on the methylmercury situation in Par Pond. Final report.** Schindler, J.E.; Williams, D.J.; Alberts, J.J. (Georgia Univ., Athens (USA). Dept. of Zoology). Jun 1975. Contract AT(38-1)-825. 22p. Dep. NTIS $4.50.

Studies are reported on the methylation and accumulation of mercury in fish populations of the pond. Results showed that the majority of the mercury in the fish muscles was in the methyl mercury form. Very low concentrations of mercury were found in the pond sediments. Physiological methylation of the mercury could not be demonstrated by in vivo or in vitro techniques. Organic ligand methylation and reduction of the mercury was shown to be a possible mechanism to account for both the mercury distribution in the pond and the concentrations of methylmercury in the fish. Recommendations are made for remedial treatments to eliminate the mercury problem. (HLW)

5670 (UCRL—77315) **Assay of sperm motility to study the effects of metal ions.** Timourian, H.; Watchmaker, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Sep 1975. 29p. (CONF-750929—2). Dep. NTIS $4.50.

From 15. symposium on the biological implications of metals in the environment; Richland, Washington, USA (29 Sep 1975).

It is difficult to assess the effects of environmental pollutants such as metal ions on the physiological and metabolic state of an organism. The concentrations and distributions of metals in different organs can be measured, but the reaction of the organism and its cells and the effects on their well being are difficult to determine. It is proposed to use the sperm motility determination as a test system in which to monitor the effects of various chemical environmental insults on an organism. The advantages of using sperm as the type cell to be sampled are discussed. Results are reported from studies on the effects of environmental Cu, Ni, and Zn on the motility of sperm from sea urchins (Strongylocentrotus purpuratus) in seawater. (CH)

5671 (ORNL-tr—2973) **Toxicological study of some substances generally present in coking plant effluents.** Leclerc, E.; Devlaminck, F. Translated by Martha Gerrard from *Cent. Belge Etude Doc. Eaux, Bull. Mens.*; **8**: 486-493(1950). 11p. Dep. NTIS $4.50.

The rule of strong acids is verified for sulfuric acids. The hemoglobin poisons, and principally potassium cyanide, are the most toxic of the poisons examined. Benzene, naphthalene, cresol, and phenol, with potassium cyanide, are the chief chemical substances on which purification should be attempted. Indirectly toxic substances, whose mechanical action (lesions, closing of the gill covers) is sometimes dangerous, are practically absent in the waters studied. Only those which come from coke quenching containing very hard particles detached from the mass. Nevertheless, they mostly float and are thus not too much of a problem. (auth)

5672 **Application of stable carbon isotope ratios as water quality indicators in coastal areas of Canada.** Tan, F.C.; Walton, A. (Bedford Inst. of Oceanography, Darmouth, Novia Scotia). pp 35-47 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The principles, applicability and limitations of the $^{13}C/^{12}C$ technique in water quality studies are discussed and critically evaluated. Preliminary results from Bedford Basin, an area which receives considerable domestic sewage effluent, and St. Margaret's Bay, Nova Scotia, Canada, a relatively pollution-free marginal bay, are presented and discussed. (auth)

5673 **Sulfur isotopic variations in relation to sulfur pollution of Lake Erie.** Nriagu, J.O. (Canada Centre for Inland Waters, Burlington, Ont.). pp 77-93 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The background sulphate concentration has been estimated to be 6.4 mg . l^{-1}, implying that the anthropogenous sources account for 60 to 70 percent of sulphate concentration in Lake Erie water. From 1850 AD, the sulphate contribution due to pollution increased at the rate of 2 mg . l^{-1} per decade, but has levelled off (at 16 mg . l^{-1}) during the last decade. An annual sulphur budget for the lake is presented and the storage time for sulphate (2.3 a) shown to be effectively the same as the water flushing time of 2.6 a. The data presented show that the sulphur inputs from the various sources may be identified on the basis of their delta^{34}S values; the use of sulphur isotopic variations to trace the movement (and mixing patterns) of the different water masses requires a further study. Only a small fraction (less than 2 percent) of the annual sulphur inputs into the lake is retained in the sediments. Dissolved sulphate in the interstitial waters (in contact with the sediments) generally disappears below 5 cm from the mud-water interface; the presence of large populations of viable sulphur cycle bacteria therefore indicates extensive microbial recycling of sulphur at the lower depths. The sediment samples analyzed show that elemental-S, organic-S and iron sulphides (hydrotroilite-mackinawite greigite and framboidal pyrite) are present in proportions that vary with the geographic location and age of the sediments. Isotopic exchange across the mud-water interface occurs with a net loss of either ^{34}S (anaerobic Central Basin sediments) or ^{32}S (aerobic Eastern Basin sediments). The distribution and isotopic composition of sulphur in the sediments of the Western Basin would suggest that the hypolimnion of the basin had been anaerobic some time in the past. (auth)

5674 **Chlorinated hydrocarbon pollutants and photosynthesis of marine phytoplankton: a reassessment.** Fisher, N.S. (Woods Hole Oceanographic Inst., MA). *Science;* **189**: No. 4201, 463-464(8 Aug 1975).

The chlorinated hydrocarbons DDT and PCB's (polychlorinated biphenyls), ubiquitous pollutants of the marine environment, have been observed to reduce the cell division rate of marine phytoplankton, thereby indirectly reducing the total photosynthetic carbon fixation in treated cultures. The photosynthetic capacity of each cell was not affected. Total marine photosynthesis will likely remain undiminished by these compounds, although alterations in phytoplankton communities through selective toxicity could affect herbivore populations.

5675 **Methane production in shallow-water, tropical marine sediments.** Oremland, R.S. (Univ. of Miami). *Appl. Microbiol.;* **30**: No. 4, 602-608(Oct 1975).

The in situ production of methane was monitored in several types of tropical benthic communities. A bed of Thalassia testudinum located in Caesar Creek (Florida Keys) exhibited the highest methanogenic activity (initial rates = 1.81 to 1.86 μmol CH_4/m^2 per h) as compared with another seagrass (Syringodium sp., 0.15 to 0.33 μmol/m^2 per h) and two coral reef environments (Hydro-Lab, 0.016 to 0.10 μmol/m^2 per h; Curacao, 0.14 to 0.47 μmol/m^2 per h). The results suggest that a wide variety of benthic metabolic processes (e.g., photosynthetic oxygen production) influences methane production rates. (auth)

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

5676 (BNWL-SA—5484) **Association of long-lived radioactivity with sediment along the Columbia River shoreline, islands, bottom and slough areas.** Fix, J.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 30p. (CONF-750967—20). Dep. NTIS $5.00.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

Since deactivation of the last once-through cooling production reactor in January 1971, radioactivity associated with sediments or biota in the Columbia River attributable to past Hanford operations decreased to very low levels. Currently only a few long-lived radionuclides are measurable and generally due to the association of these radionuclides with sediments in the river. The data available from several different monitoring programs provide a preliminary description of the extent, concentration, and physical form of these radionuclides. Data are presented on ^{137}Cs, ^{60}Co, ^{65}Zn, and ^{152}Eu in sediments sampled in 1974. (CH)

5677 (HW—47152) **Radiation aspects for river navigation through Hanford project.** Clukey, H.V. (General Electric Co., Richland, Wash. (USA). Hanford Atomic Products Operation). 7 Dec 1956. 8p. Dep. NTIS $4.50.

Declassified 9 Dec 1970.

The reach of the Columbia River through the Hanford project could be reopened to commercial navigation and limited public recreational activities, so far as radiation protection aspects shown by an initial study made in 1956 are concerned. (auth)

5678 (TID—26884) **Observations suggesting mechanisms controlling large-scale pollutant dispersal in the N. Pacific.** Folsom, T.R. (Scripps Institution of Oceanography, La Jolla, Calif. (USA)). 1974. 35p. Dep. NTIS $4.75.

Some topics discussed are: historical record of global fallout as applied to the ocean; redistribution of fallout by the moving ocean; relation of fallout distribution to concentrations of certain fallout constituents measured in sea water and marine organisms during the past decade in the North Pacific; persistence of fallout near the sea surface; vertical profiles of concentration in the ocean; and development of models for fallout studies. (HLW)

5679 **World pattern of oxygen-18 in rainwater and its importance in understanding the biogeochemical oxygen cycle.** Foerstel, H. (Nuclear Research Center, Juelich, Ger.); Putral, A.; Schleser, G.; Lieth, H. pp 3-20 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The oxygen-18 content of precipitation is the basic value for studies on photosynthetic oxygen and the water economy of plant communities using naturally occurring isotopic fractionations. Thus a world-wide pattern of the $H_{2}{}^{18}O$ content of rainwater is necessary. This pattern can be deduced with the help of the two-dimensional interpolation program SYMAP. To produce world-wide maps the available number of stations is normally not sufficient. The authors have attempted to obtain a more detailed pattern by a simple correlation study. The map was interpreted with the help of

an auxiliary program which computes latitude zonal averages (MAPCOUNT). The latitude histogram can be correlated with other information such as the productivity. The importance of a global program like SYMAP was demonstrated with the help of the $H_2{}^{18}O$ variation in precipitation. (auth)

5680 (BNL-tr—611) **Investigation of the behavior of trace elements in ocean water by the desorption method.** Gromov, V.V. Translated from *Radiokhimiya;* **16**: No. 6, 757-760(1975). 14p. Dep. NTIS $4.50.

Studies were conducted on the absorption and desorption of ^{238}Pu, ^{106}Ru, ^{99}Tc, ^{60}Co, and ^{54}Mn in equilibrium with seawater. Equations are developed for absorption and desorption of trace elements by various sorbents. Samples of ocean sediments were contaminated with radioisotopes and desorption was carried out with fresh water. Kd constants of the elements are tabulated for different types of bottom sediments and typical curves of the amounts of different elements present in the carbonate sediment are presented. (HLW)

WATER

5681 (UCRL—51913(Pt.1)) **Radiological and chemical studies of the ground water at Enewetak Atoll. 1. Sampling, field measurements, and analytical methods.** Marsh, K.V.; Wong, K.M.; Holladay, G.; Noshkin, V.E.; Buddemeier, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.; Hawaii Univ., Honolulu (USA)). 26 Sep 1975. Contract W-7405-Eng-48. 28p. Dep. NTIS $4.00.

A research program to study the ground water on several of the islets in the Enewetak Atoll is being conducted jointly by Lawrence Livermore Laboratory and the University of Hawaii under the sponsorship of ERDA Division of Biology and Environmental Research. The purpose is to provide data characterizing the ground water for possible use by returning Marshallese and to investigate the hydrology and recycling of radionuclides in an atoll environment. This first of a series of reports describes the sampling locations, field operations, and methods of analysis. (auth)

5682 **Anomalous behavior of thorium and uranium isotopes in the marine environment of the West Coast of India.** Joshi, L.U.; Ganguly, A.K. (Bhabha Atomic Research Centre, Trombay, India). pp 169-178 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

Geochemical behavior of thorium and uranium isotopes and their activity ratios have been studied in the coastal marine sediments of the West Coast region of the Indian sub-continent. The results of this study can be correlated with the transport and deposition of artificially introduced radioactivity or any run-off terrestrial pollutants in the region. In the southern part of the West Coast there are extensive placer deposits containing thorium- and uranium-bearing minerals (monazite) whereas the northern part is relatively free of such deposits. The surface layers of the coastal sediments are leached with 5 percent EDTA for the extraction of thorium and the saturated solution of ammonium carbonate for the extraction of uranium. The leaching agents are so chosen that they have high efficiency for leaching thorium and uranium and at the same time do not in any way attack the mineral core of the sediment particles. The thorium and uranium isotopic activities and the ratios $^{228}Th/^{232}Th$, $^{230}Th/^{232}Th$, $^{234}U/^{238}U$, and $^{235}U/^{238}U$ are calculated. The $^{228}Th/^{232}Th$ activity ratios in the Bombay region and in the Monazite areas are in the range 0.55 to 0.67 while the ratios in the region between Ratnagiri and Honawar are in the range 2.00 to 2.19. The $^{230}Th/^{232}Th$ activity ratios are in the range 0.13 to 0.15 in the Bombay region, 0.95 to 1.07 in the region between Ratnagiri and Honawar and 0.23 to 0.25 in the monazite areas. However, such large variations are not observed in $^{234}U/^{238}U$ activity ratios. The $^{234}U/^{238}U$ activity ratios are in the range 1.12 to 1.14 in the coastal sediments from the regions between Bombay and Kottilppad. The activity ratios $^{234}U/^{238}U$ in coastal sea-water are in the range 1.15 to 1.16. The $^{235}U/^{238}U$ activity ratios in sediments and sea-water are 0.046, which is the same as that of natural uranium. (auth)

AQUATIC ECOSYSTEMS AND FOOD CHAINS

5683 (BNWL-SA—5416) **Fixation and long-term accumulation of tritium from tritiated water in an experimental aquatic environment.** Strand, J.A.; Templeton, W.L.; Olson, P.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 24p. (CONF-751026—31). Dep. NTIS $4.50.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

The accumulation of tritium in selected freshwater biota was studied in a 10 m diameter concrete-lined pond at the Hanford Atomic Energy Works. Tritium as tritiated water was introduced for 8 months continuously in the replacement water at a concentration of μCi per liter; and water, biota (carp, clams, crayfish, periphyton, pondweed), and sediments were sampled on a predetermined schedule. The pond was maintained on uncontaminated replacement waters for an additional 8 months to determine the rate of elimination from the ecosystem. After the first day, tissue-free-water tritium in all biota approached an equilibrium with pond water. Final concentration factors of 0.89, 0.87, 0.82, 0.92, 0.77, 0.88 were calculated for carp, clam, crayfish, snail, periphyton, and pondweed. Although highly variable, analyses of pond sediments suggested an initial rapid uptake by the loose water fraction, attaining 0.30 of the pond equilibrium level in three days. There was evidence to suggest a secondary slower rate of uptake that accounted for 0.65 of the pond equilibrium level as determined at seven months. Tissue-bond tritium initially increased rapidly in all biota sampled, but slowed with time. Equilibrium conditions were not reached. Final concentration factors for carp, clam, crayfish, snail, periphyton, and pondweed were calculated to be 0.49, 0.10, 0.53, 0.54, 0.15, and 0.62. Analyses of sediments after removal of the loose water fraction revealed little or no organically bound tritium. (auth)

THERMAL EFFLUENTS MONITORING AND TRANSPORT

5684 (DP-MS—75-102) **Aeromomas in a thermally stressed lake.** Fliermans, C.B. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 5p. (CONF-751159—1). Dep. NTIS $4.50.

From Meeting of the southeastern section of American Society of Microbiology; Tampa, Florida, USA (21 Nov 1975).

Significant numbers of the fish pathogenic bacteria, Aeromonas hydrophila, survived for at least two weeks at every depth location along a thermocline in a thermally stressed, nutritionally enriched reactor cooling water basin, compared with zero survival after 4 to 5 days in a thermally unaltered aquatic system. Numbers of bacteria in samples taken during the test were based on measurements of optical density and respiration. (auth)

SITE RESOURCE AND USE STUDIES

5685 (HEDL-TME—75-38) **Fish protective devices: a compilation of recent designs, concepts, and operating experience of water intakes used in the United States.** Sonnichsen, J.C. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jul 1975. Contract AT(45-1)-2170. 86p. AT.

The report reviews concept designs and fish protective screens and devices used in the United States to protect fish. Primary emphasis is placed upon reviewing actual and proposed designs used at thermal power plants to avoid impingement and/or entrapment of fish. The design and operation of fish protection devices used in and around hydro-electric power plants and water diversion projects is also briefly discussed. To add breadth to the subject matter, an appendix has been included which contains three bibliographies compiled separately by researchers in the United States. In each case, permission to include this material was obtained from the principle author. (auth)

5686 (PRNC—188) **Cabo Mala Pascua environmental studies.** Wood, E.D.; Youngbluth, M.J.; Yoshioka, P.; Canoy, M.J. (Puerto Rico Nuclear Center, Mayaguez). 15 Jun 1975. 93p. Dep. NTIS $6.00.

Results are reported from a survey of the Cabo Mala Pascua area of Puerto Rico to determine the practicability of locating a power generating plant at the site. The geological features of the site are described and data are presented on the tides and currents; seasonal variations in water temperature, density, and salinity; the variety and biomass of zooplankton, benthic invertebrates, and fishes in the coastal waters; and plant associations of the coastal area. (CH)

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

5687 (CONF-750750—1) **Progress in evaluation of human observer visual detection performance using the ROC curve approach.** Metz, C.E.; Starr, S.J.; Lusted, L.B.; Rossmann, K. (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). 1975. 9p. Dep. NTIS $4.50.

From 4. international conference on information processing in scintigraphy; Orsay, France (15 Jul 1975).

Human observer performance in complex detection situations was analyzed. The results of these and similar studies will hopefully contribute toward development of an understanding of the relationships between physical image parameters and human observer decision performance in clinically relevant visual detection tasks. Efforts to develop an objective approach to evaluating the usefulness of diagnostic decisions which have been made on the basis of visual information are described. Applications in the interpretation of radiographs and radionuclide scans are discussed. (CH)

BIOCHEMISTRY

5688 (COO—1314-36) **Comparative mutagenesis. Progress report for period January 1, 1975—December 31, 1975.** Brockman, H.E. (Illinois State Univ., Normal (USA)). Oct 1975. Contract E(11-1)-1314. 24p. Dep. NTIS $4.50.

Progress is reported on studies of the mutagenic effects of certain acridine mustards and related compounds. Results are reported from studies on the mechanisms for the effect of compound ICR-170 in Neurospora crassa. It was concluded that oxidative metabolism is involved in the mechanism of the anoxic effect induced by ICR-170 in N. crassa. (CH)

5689 (COO—2164-14) **Effects of light intensity and PH on photosynthesis in Elodea densa.** Weber, J.A.; Gates, D.M. (Michigan Univ., Ann Arbor (USA)). Aug 1975. 10p. (CONF-750838—4). Dep. NTIS $4.50.

From Annual meeting of the Ecological Society of America with the American Institute of Biological Sciences; Corvallis, Oregon, USA (17 Aug 1975).

An apparatus is described for measuring the effects of various environmental factors on the photosynthesis of submerged macrophytes. The apparatus makes use of measurements of pH and rate of oxygen production. Data are presented for the effects of light intensity and pH on photosynthesis in the aquatic plant, Elodea densa. (HLW)

5690 (COO—3490-837) **Interaction of methylmercury and the brain biogenic amines in mice and rat pups.** Taylor, L.L. (Rochester Univ., N.Y. (USA)). 1975. 196p. Dep. NTIS $8.50.

Thesis.

The present investigation examined the interaction of methylmercury with the brain biogenic amines norepinephrine, dopamine, and serotonin. Alterations in the serotoninergic system were found after both acute and subacute exposure to this poison. In the acute study with mice, three consecutive daily intraperitoneal injections of 25 mg/kg of methylmercury chloride produced a latent period followed by a neurological period. The neurological signs observed were ataxia, dolphin-kick of the hind limbs, lessening of the ability to hold the head in a horizontal position on being hung by the tail, and loss of the righting reflex. This dose eventually resulted in death. The brain biogenic amine concentrations were determined during the latent period of the poisoning. Serotonin (5-HT) and its metabolite 5-hydroxyindole acetic acid (5-HIAA) were increased by approximately 25-30 percent above control between 4 and 6 days after the last injection of methylmercury. The catecholamines, on the other hand, were initially decreased 2 days after the last injection and subsequently increased above control 5 days after the last dose. The increased concentrations of 5-HT were associated with a drowsy appearance of the mice. This is consistent with the findings of others that increased brain levels of serotonin are associated with sleep in experimental animals. Alterations in the brain biogenic amine concentrations were studied in the rat pups after exposure to methylmercury. The nonlethal dose of 5 mg/kg/day given on days 5, 6, and 7 after birth produced an initial decrease in brain serotonin, dopamine, norepinephrine, and 5-hydroxyindole acetic acid in the treated rat pups compared to controls. Subsequently, the levels of these brain constituents increased towards and exceeded control values. (auth)

5691 (COO—3521-5) **Biological effects of radiation and related biochemical and physical studies. Progress report, September 1, 1974—August 31, 1975.** Cavalieri, L.F. (Sloan-Kettering Inst. for Cancer Research, New York (USA)). 1975. 18p. Dep. NTIS $4.50.

Results are summarized from a three-year study on the characteristics of DNA polymerases of mammalian cells, both normal and neoplastic, and the control and mechanisms of DNA replication. (CH)

5692 (JUL—1019-BO) **Light-induced development of etioplasts to chloroplasts: induction and regulation of the membrane formation.** Sprey, B. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Botanik und Mikrobiologie). Nov 1973. 245p. (In German). Dep. NTIS (US Sales Only) $9.00.

In spite of a great amount of material on the ultrastructural and biochemical aspects of chloroplast genesis from etioplasts, many detailed questions, especially the synchronization of ultrastructural and functional differentiation steps, are still unresolved. In the present work, by use of electron microscopic and biochemical methods, the individual steps of chloroplast development were analyzed. Etioplasts, turning-green plastids, and chloroplasts in vivo or in the isolated stage from the leaf buds were used as the experimental objects. The steps analyzed were the variations of the ultrastructural membrane configuration during chloroplast genesis, membrane proteins and chloroplast development, reductive pentosphosphate path and plastid differentiation, fraction I proteins, lipid synthesis and membrane formation processes, membrane isolated plastid-DNA, ribosomal RNA in plastids, synthesis of ribosomal RNA during the development of proplastids to etioplasts and chloroplasts, ribosomal RNA synthesis and light-induced chloroplast development, effect of specific inhibitors on the membrane formation, and ribosomal RNA and thylakoid membranes in plastids of chlorphyll defects. An extensive bibliography is appended. (JSR)

5693 (LBL—4412) **Prevention of sickling human erythrocytes in vitro by imidoester treatment.** Bymun, E.N. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1975. Contract W-7405-ENG-48. 57p. Dep. NTIS $5.50.

Thesis.

Previous studies have shown that sickling can be inhibited by increasing the hemoglobin-oxygen affinity. Evidence is presented here that brief treatment of human erythrocytes with a bifunctional cross-linking reagent dimethyl adipimidate at low concentrations prevents sickling, increases hemoglobin-oxygen affinity and preserves the physiological and physical properties of treated cells. Sickle erythrocytes treated with DMA washed and resuspended in original plasma showed the following properties under deoxygenated conditions: the number of sickle forms was reduced from 80 to 4 percent; the higher viscosity of sickle cells was brought into the range for normal cells; the K leak normally found under nitrogen was inhibited; red cells indices were shifted, for example, mean corpuscular hemoglobin 92 to 97 μ^3; osmotic fragility and auto hemolysis were decreased; glucose utilization and ATP synthesis were retained; the oxygen dissociation curve p50 value was shifted from 30 to 24 mm Hg. Normal cells treated under similar conditions retain normal properties. Following these initial findings with dimethyl adipimidate three monofunctional and three other bifunctional imidoesters were also examined for their effect in inhibiting sickling in vitro. (auth)

5694 (LBL—4621) **Studies on the photoconversion of protochlorophyllide to chlorophyllide in etiolated plant material.** Vaughan, G.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1975. Contract W-7405-ENG-48. 94p. Dep. NTIS $6.00.

Thesis.

The synthesis of chlorophyll (Chl) in angiosperms is dependent upon the photochemical conversion of protochlorophyllide (PChlide) to chlorophyllide (Chlide). This study attempts to elucidate the kinetics of the photochemistry, as well as some mechanistic aspects of this reaction and the spectroscopically observable changes that immediately follow it. Experiments were performed on intact leaves, on organelles (etioplasts) extracted from leaves, and on aqueous suspensions of photoactive PChlideprotein complexes (holochrome). Measurement of Chlide fluorescence excited at wavelengths where both Chlide and PChlide absorb, Chlide fluorescence yield, and polarization of Chlide fluorescence, during the photoconversion reaction in holochrome preparations from bean and barley, suggest that the photochemistry is intrinsically first-order, complicated by efficient energy transfer from PChlide to Chlide within aggregated pigment arrays. The fluorescence polarization results also demonstrate that energy transfer occurs among Chlide pigments following photoconversion. Energy transfer occurs effectively in bean holochrome, less effectively in barley extracts, and vanishes in saponin-treated barley ex-

tract. Attempts were made to measure photoinduced linear dichroism in bean holochrome, both in dried gelatin films and in solution. The failure to measure such dichroism is most readily explained by the effective depolarization of exciting illumination through energy transfer among aggregated PChlide molecules before photoconversion. (auth)

5695 (ORNL—5072, pp 2-30) **Biochemistry.** Volkin, E. Nov 1975.

In Biology Division annual progress report for period ending June 30, 1975.

Progress is reported on research activities in the fields of hemoglobin synthesis in Friend leukemia cells; tuberculin transfer factor; tRNA of methane-producing bacteria; biochemistry of Drosophila; tRNA in mammalian cells; oligoribonuclease of Escherichia coli; tRNA from the chloroplasts and cytoplasm of Euglena; protein synthesis in brine shrimp embryos; and others. (HLW)

5696 (ORO—3980-20) **Biochemical analyses of mutant and polymorphic enzymes in allelic series in Drosophila populations. Final technical report, August 15, 1969—August 14, 1974.** Johnson, F.M. (North Carolina State Univ., Raleigh (USA). Dept. of Genetics; Research Triangle Inst., Research Triangle Park, N.C. (USA). Chemistry and Life Sciences Div.). 1974. Contract AT(40-1)-3980. 11p. Dep. NTIS $4.50.

various esterases, dehydrogenases, and phosphatases in Drosophila melanogaster were investigated with regard to loci and patterns of genetic variation. Various techniques for purification of these enzymes are described. Possible relationships between enzyme genotypes and tolerance/sensitivity to different environmental conditions were examined by a series of experiments in which shock tests were employed. (HLW)

5697 Human photoreactivating enzyme. Action spectrum and safelight conditions. Sutherland, J.C.; Sutherland, B.M. (Univ. of California, Irvine). *Biophys. J.;* 15: 435-440(1975).

The action spectrum for photoreactivation by enzymes from human leukocytes and fibroblasts extends from 300 to approximately 600 nm with a maximum near 400 nm. The ability of the human enzymes to utilize light of wavelengths greater than 500 nm suggested that yellow or gold lights conventionally used as safelights for photoreactivation might serve as sources of photoreactivating light for these enzymes. Experiments using lights with a range of spectral outputs confirm that the standard yellow "safe" lights do produce photoreactivation by the human but not the Escherichia coli enzyme. (auth)

5698 Static and dynamic quenching of protein fluorescence. II. Lysozyme. McGuire, R.; Feldman, I. (Univ. of Rochester, NY). *Biopolymers;* 14: 1095-1102(1975).

Fluorescence parameters of 0.01 percent Lysozyme at 15°C in aqueous solution were measured. The results were interpreted in terms of induced conformational changes and compared with earlier data on bovine serum protein. Large decreases in the polarization of the fluorescence of lysozyme in the 0.8-1.6M and 3.2-4.8M guanidine hydrochloride ranges demonstrated two guanidine hydrochloride-induced conformation changes. A red shift of the fluorescence maximum to 354 nm indicated that the second transition completely exposes all fluorescing tryptophan residues of lysozyme to mobile solvent water. However, even 6.4M guanidine hydrochloride did not completely unravel the lysozyme molecule at 15°C, as evidenced by its failure to cause any of the tyrosine residues to become fluorescent. (JWP)

5699 Types of arginase in rat tissues. Reddi, P.K.; Knox, W.E.; Herzfeld, A. (Harvard Medical School, Boston). *Enzyme;* 20: 305-314(1975).

Significant amounts of arginase activity were found in homogenates of submaxillary.salivary gland and epididymis, as well as of liver, kidney, mammary gland, and small intestine. The isoelectric point of arginase solubilized from kidney was at pH 7.0 in contrast to that of pH 9.4 characteristic of hepatic arginase in rat. The isozymic variants of arginase in the different tissues were identified by their electrophoretic migration on polyacrylamide gels and by titration of the enzymes against antibody prepared against purified rat liver arginase. Antibody titrations confirmed the indications obtained by electrophoresis that one type of arginase is limited to hepatic tissues (and possibly submaxillary gland) while the other type is found in all other tissues. The physiological role of arginase in hepatic tissues has been previously associated with the urea cycle; the possible function of arginase in proline synthesis in other tissues remains to be substantiated. (auth)

5700 Factitious changes in binding of oxygen to hemoglobin when based on extracellular pH in the presence of certain blood additives like radiographic contrast media. Lichtman, M.A.; Whitbeck, A.A.; Murphy, M. (Univ. of Rochester, NY). *Invest. Radiol.;* 10: No. 3, 225-230(1975).

Construction of oxygen-hemoglobin dissociation curves based on extracellular pH and using blood tonometered with 5 percent CO_2 is misleading under certain experimental conditions. These include the presence in blood of poorly penetrating nonionic molecules like sucrose or poorly penetrating anionic compounds like radiographic contrast materials. False conclusions regarding the position of the oxygen-hemoglobin dissociation curve can result because of the disturbance of the normal pH gradient between plasma and red cell induced by such chemicals. (auth)

5701 Rotational allomerism and divergent evolution of domains in immunoglobulin light chains. Edmundson, A.B.; Ely, K.R.; Abola, E.E.; Schiffer, M.; Panagiotopoulos, N. (Argonne National Lab., IL). *Biochemistry;* 14: No. 18, 3953-3961(9 Sep 1975).

The crystallographic structure of a human (Mcg) lambda-type light chain (Bence-Jones) dimer was correlated with the amino acid sequence determined by J. W. Fett and H. F. Deutsch ((1974), Biochemistry 13, 4102). The observations on the denatured, fragmented, and native proteins lead to a fairly comprehensive picture of the structure of an immunoglobulin light chain. The "immunoglobulin fold" of an individual domain is a cylindrical layered structure of β-pleated sheets with a hydrophobic interior. As in the globins, the hydrophobic character of key internal sites is maintained in immunoglobulin domains which differ substantially in amino acid sequences. The differences in sequences between the V and C domains provide a striking example of divergent evolution. The cylinders have rotated in such a way that homologous regions in the two domains perform different functions in their interactions with a second molecule of light or heavy chain. Regions present in only one domain are situated in positions appropriate for their functions, but not deleterious to the general structural integrity of a common fold. (auth)

5702 Autoxidation of 6-hydroxybenzo[a]pyrene and 6-oxobenzo[a]pyrene radical, reactive metabolites of benzo[a]pyrene. Lorentzen, R.J.; Caspary, W.J.; Lesko, S.A.; Ts'o, P.O.P. (Johns Hopkins Univ., Baltimore). *Biochemistry;* 14: No. 18, 3970-3977(9 Sep 1975).

A labile metabolite of the carcinogen benzo[a]pyrene, 6-hydroxybenzo[a]pyrene, is autoxidized in aqueous buffer—ethanol solutions to produce the three stable 6,12-, 1.6 -, and 3,6-benzo[a]pyrene diones and a small amount of an unidentified paramagnetic, violet-colored material. In this reaction, oxygen is reduced to hydrogen peroxide and probably to other reactive reduced oxygen species as well. A free radical derived from 6-hydroxybenzo[a]pyrene by one-electron oxidation, 6-oxobenzo[a]pyrene radical, is most likely an obligatory intermediate in this autoxidation as indicated by its kinetics of formation and decay. In addition, this free radical can be produced quantitatively in benzene by oxidation of 6-OH-B[a]P with aqueous $K_3Fe(CN)_6$ and isolated in the absence of oxygen. Like 6-hydroxybenzo[a]pyrene, this isolated free radical is autoxidized in aqueous buffer—ethanol solutions and yields identical products. 6-Hydroxybenzo[a]pyrene is also oxidized rapidly in rat liver homogenate to the three benzo[a]pyrene diones, indicating that it is a labile precursor of these often-found products of benzo[a]pyrene metabolism. The production of reactive hydrocarbon and reduced oxygen intermediates can explain the results of previous studies which demonstrated that 6-hydroxybenzo[a]pyrene binds covalently to, and causes strand breakage in, nucleic acid. This reactivity of 6-hydroxybenzo[a]pyrene may also be related to its high toxicity toward cells in culture and its ability to morphologicallytransform Syrian hamster embryo fibroblasts. (auth)

5703 Restriction endonuclease analysis of mitochondrial DNA from grande and genetically characterized cytoplasmic petite clones of Saccharomyces cerevisiae. Morimoto, R.; Lewin, A.; Hsu, H.J.; Rabinowitz, M.; Fukuhara, H. (Univ. of Chicago). *Proc. Natl. Acad. Sci. U.S.A.;* 72: No. 10, 3868-3872(Oct 1975).

Digestion of grande mitochondrial DNA (mtDNA) by EcoRI restriction endonuclease gives rise to nine fragments with a total molecular weight of 51.8 x 10^6. HindIII digestion yields six fragments with a similar total molecular weight. Specific restriction fragments can be detected despite the fact that yeast mtDNA consists of a heterogeneous distribution of randomly broken molecules. Digestion patterns of 10 genetically characterized petite clones containing various combinations of five antibiotic resistance markers indicate that the petite mtDNA predominantly represents deletion of the grande genome. The petite mtDNAs contained up to seven EcoRI restriction fragments which comigrate with grande restriction fragments, and at least one fragment that did not correspond to any in the grande. Some strains contained multiple

fragments with mobility different from that of grande; these fragments were usually present in less than molar concentrations. The genetic markers were associated with individual sets of restriction fragments. However, several internal inconsistencies prevent the construction of a definitive genetic fragment map. These anomalies, together with the digestion patterns, provide strong evidence that, in addition to single contiguous deletion, other changes such as multiple deletion and heterogeneity of mtDNA populations are present in some of the petite mtDNAs. (auth)

5704 Analytical techniques for cell fractions. XX. Cyclic affinity chromatography: principles and applications. Anderson, N.G.; Willis, D.D.; Holladay, D.W.; Caton, J.E.; Holleman, J.W.; Eveleigh, J.W.; Attrill, J.E.; Ball, F.L.; Anderson, N.L. (Oak Ridge National Lab., TN). *Anal. Biochem.;* **68**: No. 2, 371-393(Oct 1975).

Principles and applications of an automatic cyclic affinity chromatography system, especially as applied to separation of proteins by immunosorption, are described. Use is made of columns of either immobilized antigens or antibodies to separate from a mixture, in a repetitive fashion, a desired protein or proteins by immunoadsorption followed by elution or to take from a mixture all proteins but the desired ones by allowing these latter to go through unadsorbed. The amplification provided by the cyclic use of the system and the biological amplification of hyperimmunization in achieving useful yields of desired proteins is discussed. Experience in the use of eluting solutions which do not cause damage to either the fixed or eluted proteins is presented. Representative separations done with the system are described, illustrating the different modes of use. (auth)

5705 Selective release of a deoxyribonucleic acid-binding factor from the surface of competent pneumococci. Seto, H.; Tomasz, A. (Rockefeller Univ., New York). *J. Bacteriol.;* **124**: No. 2, 969-976(Nov 1975).

Methods are described that resulted in the selective release of deoxyribonucleic acid (DNA)-binding factor from the surface of competent pneumococci. The same methods caused a parallel inactivation of the DNA-binding capacity of the extracted bacteria. Genetically or physiologically incompetent pneumococci did not yield binding factor upon exposure to the same methods. The solubilized binding factor appeared to be a protein; it could be assayed by a membrane filter binding procedure. The binding factor had properties reminiscent of those of the DNA receptors of transformable pneumococci. (auth)

5706 tRNA's associated with 70S RNA of avian myeloblastosis virus. Waters, L.C.; Mullin, B.C.; Bailiff, E.G.; Popp, R.A. (Oak Ridge National Lab., TN). *J. Virol.;* **16**: No. 6, 1608-1614(Dec 1975).

The distribution of various amino acid tRNA's in the 4S RNA components of avian myeloblastosis virus (AMV) and in 4S RNA prepared from chicken embryo cells, chicken myeloblasts, and chicken livers was determined. This was done by aminoacylating the 4S RNA samples with a mixture of 17 radioactive amino acids and subsequently identifying the tRNA-accepted amino acids on an amino acid analyzer after deacylation. In embryo cells, myeloblasts, and liver, tRNA's accepting all 17 amino acids were demonstrated. Free AMV 4S RNA was characterized by very low quantities of glutamate, valine, and tyrosine tRNA's. RNAs accepting all 17 amino acids, with the exception of tyrosine, were shown to be present in the 70S-associated 4S RNA which dissociates at 60 C. The bulk of the 70S-associated 4S RNA was dissociated at 60 C at low ionic strength with a concomitant conversion of 70S RNA to 35S RNA. The residual associated 4S RNA was dissociated by further heating of the 35S RNA to 80 C; tryptophan tRNA accounted for greater than 90 percent of the total amino acid accepting activity in this fraction. The results support other studies in suggesting that tryptophan tRNA may serve as a primer for DNA synthesis in AMV, as has been shown in Rous sarcoma virus. (auth)

5707 Adaptive enhancement of amino acid transport in human leukemic leukocytes: studies with alpha-aminoisobutyric acid. Frengley, P.A.; Lichtman, M.A.; Peck, W.A. (Univ. of Rochester School of Medicine and Dentistry, NY). *J. Lab. Clin. Med.;* **86**: No. 6, 984-996(Dec 1975).

Initial rates of accumulation (V/sub i/) of [3-^{14}C] alpha-aminoisobutyric acid (AIB) by human leukemic leukocytes increased markedly and progressively during 240 minute incubations in amino acid-deficient media. Absolute increments were greater in blast cells from patients with acute lymphoblastic leukemia and with acute myeloblastic leukemia than in lymphocytes from patients with chronic lymphocytic leukemia, but percent increments did not differ. Time-related increases appear to be restricted to an active mechanism for AIB entry and could not be attributed to cell damage, concomitant alterations in the incubation media, or progressive reduction in transinhibition of AIB entry. Studies with two cell populations revealed these increases to be associated with an augmented V/sub max/ and a reduction in apparent K/sub m/, suggesting enhanced capacity and affinity of the transport system for AIB. Time-related increases failed to develop in two chronic lymphocytic leukemia (CLL) lymphocyte populations and were partially reduced in two leukemic blast cell populations during continuous exposure to high extracellular AIB concentrations. Hence, this phenomenon may represent an adaptive response to environmental amino acid deprivation. Adaptation may involve de novo protein and RNA synthesis, since it was not seen in cells which were treated with cycloheximide or actinomycin D. However, unlike previous observations in nonmalignant cells, once triggered, the adaptive response was not completely suppressed in leukemic cells which underwent a large degree of adaptation. (auth)

5708 Yeast DNA photolyase: molecular weight, subunit structure, and reconstitution of active enzyme from its subunits. Boatwright, D.T.; Madden, J.J.; Denson, J.; Werbin, H. (Univ. of Texas, Dallas). *Biochemistry;* **14**: No. 25, 5418-5421(16 Dec 1975).

Yeast DNA photolyase, purified by affinity chromatography, ran as a single component when analyzed by either electrophoresis on polyacrylamide gradient gels or by sedimentation velocity through 5-20 percent sucrose gradients containing 0.4 M KCl, and, therefore, was considered homogeneous. The molecular weights of photolyase, determined by these methods, were 130,000 and 136,000, respectively. When the enzyme was examined by electrophoresis on sodium dodecyl sulfate polyacrylamide gradient gels, it dissociated into two bands whose molecular weights were 60,000 and 85,000. After the enzyme was sedimented through sucrose gradients in the presence of 1.0 M KCl, two absorbance maxima, which corresponded to polypeptides of 54,000 and 82,500, were found in the fractions collected. Thus, the enzyme consists of two dissimilar subunits. When the two fractions that exhibited maximal absorbance were mixed together, a time-dependent increase in activity occurred, demonstrating that active enzyme could be reconstituted from these subunits. Analysis of sucrose gradients containing 1.0 M salt for photolyase activity showed that it was present exclusively in the region of the gradient corresponding to 68,200 in agreement with a previous report. These active fractions were found in the overlap region between the two subunits, and their activity was attributed to reconstitution of the enzyme during the assay. (auth)

5709 ^{13}C Fourier transform nuclear magnetic resonance studies of fractionated Candida utilis membranes. London, R.E.; Kollman, V.H.; Matwiyoff, N.A. (Los Alamos Scientific Lab., NM). *Biochemistry;* **14**: No. 25, 5492-5500(16 Dec 1975).

^{13}C Fourier transform nuclear magnetic resonance has been used to study the lipid structure and dynamics of fractionated Candida utilis cell membranes. Measurements of the spin-lattice relaxation times indicate the existence of mobility gradients in the direction of increased mobility from the glycerol backbone toward the terminal methyl group of the fatty acid and toward the choline methyls. The temperature dependence of the relaxation times gives activation energies of approximately 4-6 kcal/mol for the rotations about the various carbon-carbon bonds which determine the relaxation rates. In general, comparison with data which have been reported for artificial membrane systems indicates that the contributions of protein-lipid interactions to the T_1 gradient are of negligible importance in the yeast membrane system. A dynamical model for the motion about bonds near unsaturated bonds which determines the relaxation of the unsaturated carbons is also proposed. Measurements of chemical shifts with temperature also exhibit a correlation with chain position. On the basis of these data a correlation of ΔE, the energy difference between gauche and anti conformations for γ carbons, with chain position is inferred. In addition, an estimate of 1.2 kcal/mol can be obtained for ΔE for carbons near the end of the fatty acid chain. This value indicates that intermolecular interactions contribute substantially to ΔE since a value of approximately 0.5 kcal/mol can be ascribed to intramolecular interactions. (auth)

TRACER TECHNIQUES

5710 (LA-UR—75-1986) **Carbon-13 NMR studies of membranes enriched with carbon-13.** Matwiyoff, N.A.; London, R.E.; Kollman, V.H. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 28p. (CONF-751027—5). Dep. NTIS $5.00.

From 2. international conference on stable isotopes; Oak Brook, Illinois, USA (20 Oct 1975).

^{13}C FT nmr has been used to study the lipid structure and dynamics of fractionated Candida Utilis cell membranes. Measurements of the spin lattice relaxation times indicate the existence of

mobility gradients in the direction of increased mobility from the glycerol backbone toward the terminal methyl group of the fatty acid and toward the choline methyls. The temperature dependence of the relaxation times gives activation energies of ca. 4 to 6 kcal/mole for the rotations about the various carbon-carbon bonds which determine the relaxation rates. (auth)

5711 Pharmacokinetic studies of metoprolol-(^{3}H) in the rat and the dog. Borg, K.O.; Fellenius, E.; Johansson, R.; Wallborg, M. *Acta Pharmacol. Toxicol., Suppl.;* **36**: No. 5, 104-115(1975).

The gastrointestinal absorption, the renal, biliary and faecal excretion and blood/plasma levels of metoprolol-(^{3}H) in the rat and the dog are described. The compound was well absorbed in both species, about 70 to 100 percent of the given dose being recovered from the urine within 24 hours irrespective of the route of administration. Low radioactivity was found in faeces and bile. The drug was rapidly and extensively distributed to extravascular tissues, the half-life of the distribution process being 5 to 10 minutes. The half-life for the elimination phase in the rat was about 0.6 hours and independent of dose and route of administration. The corresponding figure in the dog was about 1.5 hours. The systemic bioavailability of metoprolol-(^{3}H) was about 4 percent in the rat and in the range 20 to 40 percent in the dog. The peak concentrations of metoprolol after oral administration were approximately proportional to the dose given. Short-term treatment with metoprolol had no effects on the pharmacokinetics of the drug. Since the pharmacokinetic characteristics, obtained by interpreting the blood/plasma curve in terms of a two-compartment open model, were rather similar in the dog and in man it is concluded that the dog can serve as a better model for human experiments with this drug than the rat. (auth)

CYTOLOGY

5712 (CONF-751219—1) **Nu models for chromatin structure.** Olins, A.L.; Breillatt, J.P.; Carlson, R.D.; Senior, M.B.; Wright, E.B.; Olins, D.E. (Tennessee Univ., Oak Ridge (USA). Graduate School of Biomedical Sciences; Oak Ridge National Lab., Tenn. (USA)). 1975. 50p. Dep. NTIS $5.00.

From Conference on molecular biology of the mammalian genetic apparatus, its relationship to cancer aging and medical genetics; Pasadena, California, USA (8 Dec 1975).

Progress is reported on biochemical and electron microscopic studies on the structure of chromatin. (CH)

5713 (COO—3110-20) **Cultured haploid cells resistant to antitubulins.** Freed, J.J.; Ohlsson-Wilhelm, B.M. (Institute for Cancer Research, Philadelphia, Pa. (USA)). 1975. 12p. (CONF-750995—1). Dep. NTIS $4.50.

From International symposium on microtubules and microtubular inhibitors; Beerse, Belgium (2 Sep 1975).

Variants from cultured animal cell lines that have been selected for resistance to antitubulins have been shown in several instances to owe their resistance to reduced uptake or accelerated efflux of the drug. This form of resistance is termed drug-exclusion; it is non-specific, in that the variants also acquire resistance to drugs unrelated in both molecular structure and cellular target systems. In this article, we describe several antitubulin-resistant strains that we have selected from cell line ICR B20, a haploid isolate derived from the stable haploid cell line ICR 2A. In these, resistance is specifically directed toward the alkaloid used as the selecting agent while the cells remain as sensitive as the parental stock to other antitubulins. In one strain, selected for resistance to podophyllin, cross-resistance to colchicine has been detected, although the cells remain sensitive to vinblastine. This phenotype is of particular interest, since podophyllin and colchicine appear to bind to a common site on the tubulin molecule while vinblastine binds independently. The specificity of resistance in the haploid cell varients suggests that they may arise independently of the more common, non-specific, drug-exclusion mechanism. (auth)

5714 (KFK-EXT—6/75-3) **Newsletter '75 in stereology.** Ondracek, G. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Material- und Festkoerperforschung). Aug 1975. 76p. (In German and English). Dep. NTIS (US Sales Only) $5.00.

General stereological problems in imaging biological materials are discussed. A new attempt is made to calculate the number of dispersed particles per volume of a spatial aggregate. A definition of one and two dimensional size is described based on probabilistic background. This definition is related to the frequency of random intercepts taking place by considering a particle of given shape in an uniform field of straight lines. As a contribution to stereometry, or the measurement in three dimensions necessary to study the structure in three dimensions, a test system based on point counting is described. (auth)

5715 (LA—6075-PR) **Application of cell-analysis and sorting techniques to disease detection. Progress report, July 1, 1974—June 30, 1975.** Cram, L.S.; Forslund, J.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-ENG-36. 5p. Dep. NTIS $4.00.

Application of rapid cell-analysis and sorting techniques to the differential diagnosis of Newcastle virus disease (NDV) in chickens and bovine tuberculosis is described. A large variety of NDV strains were studied to determine the generality of a previously reported correlation between strain virulence and cell-fusion ability. Several highly virulent strains were found that produced very little cell fusion. However, cell-fusion ability as measured by FMF data is a characteristic and reproducible property of each NDV strain. Tuberculosis in cattle has been successfully detected and diagnosed by measuring the response of lymphocytes to specific mitogens. (CH)

5716 (LBL—4616) **Biochemical and spectroscopic studies of protochlorophyllide holochrome and its role in the formation of photosynthetic membranes.** Canaani, O.D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1975. Contract W-7405-ENG-48. 153p. Dep. NTIS $6.75.

Thesis.

The assembly of the photosynthetically active membrane of chloroplasts is triggered by Chl synthesis. This process takes place when dark-grown seedlings are subjected to illumination. It involves a photoreduction of PChlide to Chlide at a protein site. The photoconversion can be studied using an extracted pigment-protein complex called PChlide-holochrome (PCH). (auth)

5717 (UCLA—12-1019) **Cellophane sandwich explant system.** Cole, R.; de Vellis, J. (California Univ., Los Angeles (USA)). 1975. Contract E(04-1)-GEN-12. 8p. Dep. NTIS $3.50.

A simplified tissue explant system for rat embryo brain tissue was developed to provide sufficient material in each culture to perform standard biochemical procedures without the interfering protein substances of collagen, plasma, or gelatin and to do so with a minimum of time and expense. Perforated cellophane was utilized for the growth and maintenance of organotypic structures which closely resemble the analogous in-situ tissue. By placing these structures in a more defined environment, their external factors can be modified by design and their biochemical parameters analyzed. This procedure utilizes two pieces of perforated cellophane with tissue explants sandwiched between, thus allowing the explants to be lightly anchored in position while permitting cellular migration under, between, and above the cellophane layers. Outgrowth from the explant is rapid, medium changes fast, and the tissue morphology is unaltered by the mechanics of manipulation. A sufficient amount of tissue can be grown in each culture to permit the use of standard biochemical analytical procedures. (CH)

5718 (UCRL—51956) **BMB: a poor fluorescent descriptor for cervical dysplasia.** Weintraub, H.B.; Jensen, R.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Nov 1975. Contract W-7405-Eng-48. 16p. Dep. NTIS $4.00.

The fluorochrome 4-bromomethyl-7-methoxy-2-oxo-2H-benzopyran (BMB) was reacted with human cervical cells to determine whether its apparent binding specificity for t-RNA might label and identify proliferating cancer cells in a heterogeneous cell population. Cell suspensions from cervical specimens and morphologically characterized cervical cells fixed on slides were stained with BMB and the fluorescent intensity was measured to determine the extent of reaction of BMB with randomly selected cervical cells from the cell suspensions and with the morphologically characterized cervical cells on slides. The measurements showed BMB fluorescence develops slowly in stained cervical cells, BMB binds primarily to cellular components, other than t-RNA; consequently cell fluorescence correlates somewhat with cell area. Cell fluorescence does not correlate with cell type or patient diagnosis, and therefore BMB cannot be used to diagnose cervical dysplasia. (auth)

5719 (UCRL—77533) **New directions for flow cytometry: chromosome analysis.** Van Dilla, M.A.; Gray, J.W.; Carrano, A.V.; Minkler, J.L.; Steinmetz, L.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Nov 1975. 12p. (CONF-750957—3). Dep. NTIS $-4.50.

From 2. international symposium on pulse cytophotometry; Munster, F.R. Germany (17 Sep 1975).

The conventional chromosome analysis (karyotype) is based on the number, size, shape, and centromeric position of the stained chromosomes in metaphase spreads. Recently developed banding techniques improve chromosome identification, so that now all the chromosomes of human metaphase spreads can be identified visually. Scanning cytophotometry is a quantitative method whereby the DNA content and centromeric index of each chromosome in a metaphase spread can be measured and thus

yield new information about chromosomes. The new flow method constitutes an additional approach to the study of chromosomes and has the advantages of precise DNA measurement, rapidity, and sorting into purified populations. (auth)

5720 Appearance of cytoplasmic informosomes in cultured Chinese hamster cells in the absence of protein synthesis. Enger, M.D.; Campbell, E.W.; Hanners, J.L. (Los Alamos Scientific Lab., NM). *FEBS (Fed. Eur. Biochem. Soc.) Lett.*; 55: No. 1, 194-197(Jul 1975).

It is demonstrated that nascent free informosomes appear in the cytoplasm of Chinese hamster cells during culture at 42°C, a condition which causes rapid and essentially complete inhibition of translation initiation. (ERB)

TRACER TECHNIQUES

5721 (BNL—20532) **Deuterium micromapping of biological specimens: detection sensitivity.** Slatkin, D.N.; Jones, K.W. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 20p. (CONF-751027—2). Dep. NTIS $4.50.

From 2. international conference on stable isotopes; Oak Brook, Illinois, USA (20 Oct 1975).

The development of a technique for micromapping subpicogram quantities of deuterium in cells by using the $D(T,n)^4He$ reaction and plastic track detectors is described. This was developed with a view toward applying deuterated DNA precursors such as thymidine to studies of human cell proliferation kinetics in infants and other subjects in whom the use of tritiated DNA precursors may not be advisable. The method should also be generally useful as a precise and sensitive means of localizing small amounts of deuterium in thin specimens. A study of damage to blood cells by ~200 keV tritons (T^+) was carried out under several experimental conditions. By cooling the specimen in helium at ambient temperature and 0.4 atmosphere pressure, a triton fluence of about 1.2 x 10^{18} cm^{-2} can be attained with only subtle effects on blood cell morphology. The useful upper limit of fluence now appears to be about 2.2 x 10^{16} tritons-cm^{-2} due to radiation damage to cells, but the maximum tolerable flux has not yet been determined. No detectable thermal damage to cells is observed for a flux less than 6 x 10^{12} tritons-sec^{-1} cm^{-2}. The results of the present work are discussed in the context of its proposed application to the use of deuterated DNA precursors in medical research. (auth)

GENETICS

5722 (CONF-751211—2) **Glucocorticoid control of gene expression.** Kenney, F.T.; Lane, S.E.; Lee, K.L.; Ihle, J.N. (Oak Ridge National Lab., Tenn. (USA)). 1975. 28p. Dep. NTIS $5.00.

From Symposium on modified cellular and molecular controls in neoplasia; Honolulu, Hawaii, USA (9 Dec 1975).

The concept that glucocorticoids function at the nuclear level to control expression of specific genes is discussed. The current views on the mechanism of this control are presented and relevant data from different experimental approaches are reported. (CH)

5723 Sister chromatid exchange in xeroderma pigmentosum cells that are defective in DNA excision repair or post-replication repair. Wolff, S.; Bodycote, J.; Thomas, G.H.; Cleaver, J.E. (Univ. of California, San Francisco). *Genetics;* 81: No. 2, 349-355(Oct 1975).

The formation of sister chromatid exchanges has been postulated to depend upon the action of DNA repair enzymes. Our experiments with various human cell lines show that the yield of sister chromatid exchanges is within normal limits in both excision-repair-defective and post-replication-repair-defective cells from the autosomal recessive disease, xeroderma pigmentosum. These results indicate that hypotheses invoking known DNA repair processes to account for the recombination of sister chromatids are inadequate and that the exact enzymatic processes are as yet unknown. (auth)

METABOLISM

5724 (CEA-R—4689) **Investigations on the metabolism of metals in decapod crustaceas in relation with moulting cycles and reproduction.** Martin, J.L.M. (CEA Centre de La Hague, 50 - Cherbourg (France). Service de Recherches Toxicologiques et Ecologiques). Jul 1975. 320p. (In French). Dep. NTIS (US Sales Only) $10.75.

Thesis. Submitted to Aix-Marseille Univ., France.

A study of the matabolism of metals was carried out in decapod crustaceas; it showed that it was subject to cyclic variations during the life of the animals, closely correlated with growth moults. The metabolism of metals was also considered in its relations with reproduction, especially oogenesis and spermatogenesis, and embryonic development. In relation with moult, various factors playing a role on metal metabolism were investigated: role of metals in the organism, fasting and nutrition cycles and biochemical reserves, physico-chemical form of the metal and ultrastructure of uptake surfaces. The histological and histochemical aspects of the uptake of a number of metals were studied as well as intermetallic and inter-organic relationships. (auth)

5725 (CONF-751040—2) **Differences in early retention of lead acetate and lead citrate in mouse tissues.** Baxter, D.W.; Doan, N.G.; Lindenbaum, A. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 20p. Dep. NTIS $4.00.

From A talk to American Society for quality control; Richland, Washington, USA (23 Oct 1975).

Lead acetate (73 percent ultrafilterable) or lead citrate (93 percent ultrafilterable) containing tracer amounts of ^{210}Pb was intravenously injected (1 mg/kg at pH 5.1) into 85 day old $B6CF_1$ female mice, and a comparison of lead accumulation and rate of loss from liver, spleen, kidney, femur, lung, brain, and blood was made at intervals up to 14 days. At one hour, mice injected with lead acetate accumulated 51.1 percent of the injected dose per gram of tissue (percent ID/g) in the liver and 18.4 percent ID/g in the spleen, while mice injected with lead citrate contained 17.6 percent ID/g in the liver and 3.6 percent ID/g in the spleen. In contrast, animals injected with lead acetate accumulated lower levels of lead in kidney and femur at one hour than were found in animals injected with lead citrate: kidneys contained 35.3 percent ID/g following lead acetate injection and 63.4 percent ID/g following lead citrate injection, while femurs contained 11.3 percent ID/g after lead acetate and 22.5 percent ID/g after lead citrate. Animals given lead acetate tended to accumulate more lead in lung and less in brain and blood at one hour than those given lead citrate. The rate of loss of lead between one hour and 14 days was greater from liver and spleen following lead acetate, but greater from kidney following lead citrate. These data indicate that the distribution and kinetics of lead in living tissues are influenced by physical factors such as particulate size of the administered substance. The data also suggest that lead acetate undergoes hydrolysis in blood and is more rapidly converted to the particulate state than lead which is administered at the more stable citrate complex. (auth)

5726 (COO—1422-8) **Body composition determination by differential photon absorption technique.** Sorenson, J.A.; Cameron, J.R. (Wisconsin Univ., Madison (USA). Dept. of Radiology). 1975. 9p. Dep. NTIS $4.50.

Applications of the differential photon absorption technique for the estimation of the amount of fat in muscles are discussed. The attenuation by the sample of two monochromatic photon beams was determined from successive measurements of photon transmission rates using a scintillation detector, amplifier-analyzer, and a scalar with an electronic timer. The photon sources used were 50 to 100 mCi of ^{125}I and ^{241}Am. (CH)

5727 (COO—3173-14) **Effects of stable iodide blocking of exposure to radioiodine. Progress report, November 1, 1974—October 31, 1975.** Becker, D.V.; Belshaw, B.E. (Duke Univ., Durham, N.C. (USA). Dept. of Zoology). 1975. Contract E(11-1)-3173. 16p. Dep. NTIS $4.50.

Results are reported from studies on the influence of dietary iodine intake on the uptake of ^{131}I by the thyroid gland of beagles. A model of iodine kinetics in normal dogs was developed that consists of separate subsystems for iodine, thyroxine, triiodothyronine, and the thyroid gland. The model demonstrates important differences in iodine metabolism and thyroid function between the dog and man. (CH)

5728 (FMI—1000-605) **Regulation of erythropoiesis in clinical disease states.** (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). 1975. 11p. (CONF-751201—1). Dep. NTIS $4.50.

From William D. Robinson symposium; Ann Arbor, Michigan, USA (13 Dec 1975).

Studies on the physiology of erythropoiesis are reviewed. Some topics discussed are use of radioactive iron in the assay of erythropoietin; evidence for erythropoietin as the regulator of erythropoiesis; decrease in production of erythropoietin following removal of kidneys in rats; increase in erythropoietin as response to hypoxia; erythropoietin excess in primary anemias and secondary polycythemia; and erythropoietin deficiency in secondary anemias and primary polycythemia. (HLW)

5729 Structural-functional relationships in platelets in acute leukemia and related disorders. Cowan, D.H. (Cleveland Metropolitan General Hospital); Graham, R.C. Jr. *Ser. Haematol. (Copenhagen)*; 8: No. 1, 68-100(1975).

From 15. congress of the International Society of Hematology; Jerusalem, Israel (Sep 1974).

Platelet ultrastructure and adenine nucleotide metabolism were studied in acute leukemia in order to elucidate mechanisms for the functional defects of platelets in this clinical setting. A number of structural defects were observed: giant platelets, marked variability in the number and size of cytoplasmic granules, dilatation of the open channel system, cytoplasmic vacuolization, and poorly delineated microtubular system. Metabolic defects included reduced cellular concentrations of ATP and ADP and selective reduction of the storage pool (non-metabolic) nucleotides. Stimulation of platelets was associated with delayed and incomplete granule migration, reduced degranulation, subnormal release of ATP and ADP, and poor platelet aggregate formation. The structural and metabolic defects observed indicate abnormalities exist in the contractile mechanism and the release reaction of platelets in acute leukemia which partly explain the functional defects reported previously. Platelets from patients with pre-leukemic states share some of the structural and metabolic defects seen in acute leukemia. The defects are less uniform consistent with a lesser degree of functional impairment than that seen in acute leukemia. Studies of megakaryocytic ultrastructure suggest that the structural defects seen in acute leukemia and pre-leukemia may arise in the late stages of megakaryocyte maturation. (auth)

5730 Phosphocellulose, an affinity chromatographic system for chorismate synthase and the aromatic complex of Neurospora crassa. Cole, K.W.; Gaertner, F.H. (Oak Ridge National Lab., TN). *Biochem. Biophys. Res. Commun.*; 67: No. 1, 170-175(1975).

Unlike other enzymes of the aromatic multienzyme system, chorismate synthase and the aromatic complex of Neurospora crassa were found to bind to a column of cellulose phosphate and to elute at a relatively high concentration of phosphate (approximately 0.2 M). The fact that other enzymes with similar ionic properties failed to bind to phosphocellulose suggests that the binding of the former two enzyme systems is due to a specific affinity for phosphate. This conclusion is not only supported by the fact that these same enzymes did not bind to a column of carboxymethyl cellulose, but also is consistent with the nature of the catalytic reactions of the enzymes. Both the shikimate kinase enzyme of the aromatic complex and chorismate synthase would be expected to have active sites which accommodate a phosphate moiety. We anticipate that other enzymes which involve phosphosubstrates will also be amendable to this procedure. (auth)

5731 Vitamin D: induced changes in the renal membrane ATPase system. Shamoo, A.E.; Bronner, F. (Univ. of Rochester, NY). *Calcif. Tissue Res.*; 17: 189-194(1975).

Ca-dependent and Mg-dependent ATPase activity was found to be depressed significantly in renal membrane preparations from vitamin D-deficient as compared to normal rats. Administration of 2000 i.u. vitamin D_3 to deficient rats 30 hours before sacrifice restored the membrane enzyme activity to normal. ATP binding by enzymes was also reduced in vitamin D deficiency and raised by repletion. Vitamin D may therefore be required for normal Ca- and Mg- dependent ATPase activity. (auth)

5732 Prostaglandin E_1 induced changes in cyclic AMP levels in WI-38 human fibroblasts. Two different effects of cell density. O'Neill, J.P.; Hsie, A.W. (Oak Ridge National Lab., TN). *Biochim. Biophys. Acta;* 404: 243-248(1975).

WI-38 lung diploid fibroblasts respond to prostaglandin E_1 with increased levels of cyclic adenosine 3':5'-monophosphate. This increase is affected by cell density in two ways: (a) The initial rate of accumulation of intracellular cyclic AMP increases with increasing cell density. (b) However, the elevated levels of cyclic AMP are more stably maintained in lower-density cells, and this stability decreases with increasing cell density. Cyclic AMP phosphodiesterase activities, as well as the efflux of intracellular cyclic AMP into the medium are similar at all cell densities. (auth)

5733 Variations in the $^{13}C/^{12}C$ isotopic ratio in the animal metabolism. Lacroix, M.; Mosora, F. (Univ. Liege, Sart Tilman, Belgium). pp 343-358 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975). (In French)

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

Following the work undertaken by Duchesne et al., a synthesis of the results obtained since 1968 is presented. Differences up to 10 percent are observed in the isotopic ratio $^{13}C/^{12}$ of the CO_2 exhaled by various animals as a function of their diet and especially of the presence in their diet of vegetables characterized by a C4 photosynthetic pathway (such as maize). Weak but significant variations of the CO_2 isotopic ratio are also observed during starvation, after injection of hormones which regulate the glycaemia or even simply in relation to the metabolic rhythms of normal digestion; these variations seem to be correlated with the modifications arising in the relative proportion of substrates from which carbon dioxide is formed. Small isotopic fractionations, appearing mainly in bones and fats, were also shown by combustion of various tissues. Moreover, a change in diet (use of corn) affects clearly, not only the exhaled CO_2, but also, within a few days, the mean ^{13}C content of organs, mainly in the case of the liver. These metabolic fractionations remain, however, limited enough to use the ^{13}C content, naturally a little higher, of C4 photosynthetic vegetables as a tracer in order to follow some metabolic processes. An application of this is presented by way of a glucose tolerance test. (auth)

5734 Relationship of the first step in protein synthesis to ppGpp: formation of A(5')ppp(5')Gpp. Rapaport, E.; Svihovec, S.K.; Zamecnik, P.C. (Harvard Univ., Boston). *Proc. Natl. Acad. Sci. U.S.A.*; 72: No. 7, 2653-2657(Jul 1975).

In the presence of purified Escherichia coli lysyl-tRNA synthetase [L-lysine:tRNA/sup Lys/ ligase (AMP-forming), EC 6.1.1.6], L-lysine, and ATP, addition of the nucleotide ppGpp results in formation of a unique product—A(5')ppp(5')Gpp. The same compound is also formed very rapidly in a cell-free protein-synthesizing system when ppGpp is added. The possible significance of this reaction in the rapid turnover of ppGpp and as a more general mechanism by which an AMP residue is activated and introduced onto a 5'-diphosphorylated species, including the 5'-end of an RNA, is further discussed. (auth)

5735 Novel oligoribonuclease of Escherichia coli. I. Isolation and properties. Niyogi, S.K.; Datta, A.K. (Oak Ridge National Lab., TN). *J. Biol. Chem.*; 250: No. 18, 7307-7312(25 Sep 1975).

A new ribonuclease has been isolated from Escherichia coli. The enzyme is present in the 100,000 x g supernatant fraction and has been purified over 200-fold. Studies of the enzyme reveal that: The enzyme shows a marked preference for oligoribonucleotides; indeed, the reaction rate is inversely proportional to the chain length of the substrate. The enzyme does not attack polynucleotides even at high concentrations of enzyme and has no detectable DNase activity. The enzyme is stimulated strongly by Mn^{2+}, less strongly by Mg^{2+} and not at all by Ca^{2+} and monovalent cations. The enzyme is purified free of RNase I, RNase II, RNase III, polynucleotide phosphorylase, and other known ribonucleases of E. coli. The enzyme displays identical properties when isolated from mutants of E. coli that are deficient in the above ribonucleases. The enzyme has a marked thermostability, a point of further distinction from RNase II. (auth)

5736 Novel oligoribonuclease of Escherichia coli. II. Mechanism of action. Datta, A.K.; Niyogi, S.K. (Oak Ridge National Lab., TN). *J. Biol. Chem.*; 250: No. 18, 7313-7319(25 Sep 1975).

The mechanism of action for a ribonuclease from Escherichia coli with remarkable specificity for short oligoribonucleotides is described. The enzyme attacks exonucleolytically (from the 3' end) to produce 5'-ribonucleotides. Evidence suggests the hydrolysis is processive. It is suggested that this enzyme may serve as a "Finishing enzyme" which hydrolyzes oligoribonucleotides that remain after RNase II hydrolysis of RNA. (JWP)

MEDICINE

5737 (BMFT-FBK—75-05) Comparison of conventional and nuclear medicine research methods in the area of nephro-urology. Pfannenstiel, P. (Deutsche Klinik fuer Diagnostik, Wiesbaden (F.R. Germany)). Oct 1975. 208p. (In German). Dep. NTIS (US Sales Only) $8.75.

A simplification of the ^{131}I-hippuran total body clearance method for testing kidney function is described. The renal clearance can now be calculated with only one scintillation detector after i.v. injection of ^{131}I-hippuran. (CH)

5738 (CONF-741230—4) Effect of x-ray spectra from molybdenum and tungsten target tubes on image quality in mammography. Haus, A.G.; Metz, C.E.; Chiles, J.T.; Rossmann, K. (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). 1975. 10p. Dep. NTIS $4.50.

From Radiological Society of North American Conference; Chicago, Illinois, USA (1 Dec 1974).

Measured x-ray spectra from a molybdenum-anode mammography x-ray unit and from a tungsten anode unit were used to calculate the x-ray energy spectra transmitted through various thicknesses of fat and water (breast-equivalent materials). The dependence of subject contrast and patient exposure on x-ray spectra, attenuation properties of the two breast-equivalent materials, and thickness of breast-equivalent material is predicted. Radiographs of resected breast tissue confirm these predictions and demonstrate the general relative effects of x-ray beam quality on image contrast in mammography. (auth)

5739 (LBL—3040) **Comparison of heavy charged particles and x-rays for axial tomograpic scanning.** Huesman, R.H.; Rosenfeld, A.H.; Solmitz, F.T. (California Univ., Davis (USA). Dept. of Engineering). Sep 1975. Contract W-7405-ENG-48. 16p. Dep. NTIS $4.00.

Heavy charged particles are applicable to the problem of 3-dimensional reconstruction of electron density distributions of biological samples. The transverse uncertainty in the path of a heavy charged particle due to multiple scattering can be reduced by measuring the entrance and exit positions and angles of the particle. Patient doses for He ions and 80 keV x rays are compared under conditions suitable for imaging the human head. (auth)

5740 Development on the implantation of a total nuclear-powered artificial heart system. Smith, L.; Backman, K.; Sandquist, G.; Kolff, W.J.; Schatten, K.; Kessler, T. (Inst. for Biomedical Engineering, Salt Lake City). *Trans., Am. Soc. Artif. Intern. Organs;* **20**: 732-735(1974).

In 1971 the United States Atomic Energy Commission initiated the development of a totally implantable nuclear-powered artificial heart. Early in 1972 a bench model was designed, constructed and tested. The implantable nuclear-powered heart consists of 2 main sub-systems: the thermal converter which serves as a power supply and the blood pump mechanism. Rotational mechanical power is transmitted from the thermal converter to the blood pump via a flexible drive shaft. The thermal converter is a gas driven Sterling cycle engine which uses a 33 watt, 60 Gm ^{238}Pu heat source. For a 10-yr life expectancy the Sterling cycle engine offers the advantage of increased reliability, most of the seals with critical dimensions and tolerances are maintained in the cooler regions of the engine, where longevity of these components is increased because of reduced wear and fatigue. Plutonium-238 was chosen because of its long half life of 88 yr and because the major decay products are high energy alpha and low energy gamma rays, which are readily shielded from the recipients. Power transmitted to the blood pump is converted into linear reciprocating motion by a scotch yoke mechanism. Two pusher cups attached to this mechanism pump the blood alternately. Ventricle diaphragms are attached and sealed to the pusher cups with a roll-sock connection which reduces fatigue by minimizing flexing in the diaphragm. Future prototype modifications could increase the efficiencies, further reducing the isotope inventory and cost. Results of studies on calves to determine tolerance of the chronic effects of weight and size of such an implant in the abdominal region over extended periods of time and to test the bench model blood pump for the sake of simplicity are reported. (CH)

5741 New device for accurate measurement of the x-ray intensity distribution of x-ray tube focal spots. Doi, K.; Fromes, B.; Rossmann, K. (Univ. of Chicago). *Med. Phys.;* **2**: No. 5, 268-273(1975).

A new device has been developed with which the focal spot distribution can be measured accurately. The alignment and localization of the focal spot relative to the device are accomplished by adjustment of three micrometer screws in three orthogonal directions and by comparison of red reference light spots with green fluorescent pinhole images at five locations. The standard deviations for evaluating the reproducibility of the adjustments in the horizontal and vertical directions were 0.2 and 0.5 mm, respectively. Measurements were made of the pinhole images as well as of the line-spread functions (LSFs) and modulation transfer functions (MTFs) for an x-ray tube with focal spots of 1-mm and 50-μm nominal size. The standard deviations for the LSF and MTF of the 1-mm focal spot were 0.017 and 0.010, respectively. (auth)

5742 Kinetics of hemolytic plaque formation. III. Inhibition of plaques by antigen. DeLisi, C. (Los Alamos Scientific Lab., NM). *J. Theor. Biol.;* **51**: 337-345(1975).

Equations are presented which can be used to describe the inhibition of plaques by multifunctional antigen which binds γG antibody bivalently. The interaction is treated as a bimolecular reaction which is irreversible within the time of the experiment. Under these conditions the characteristics of the inhibition curve, and their relationship to kinetic and thermodynamic parameters are strongly dependent upon how antibody interacts with RBCs. When the epitope coating is dense, multivalent attachment of antibody is likely and the interaction is considered irreversible. When the epitope coating is sparse, only rapid, reversible univalent attachment is considered and local equilibrium is assumed to hold. The first case leads to an abrupt inhibition curve whose position is determined by the forward rate constant and RBC density. The second case leads to broad asymmetric curves. For this situation the relation between the extent of inhibition and the affinity of the population is generally complicated and reliable affinity information is difficult to obtain. This is contrasted to results obtained previously for unifunctional inhibitors from which reliable affinity information can, in principle, be obtained. The results emphasize the need for carefully designed experiments if affinity information is to be obtained from inhibition studies. (auth)

5743 Kinetics of hemolytic plaque formation. II. Inhibition of plaques by hapten. DeLisi, C. (Los Alamos Scientific Lab., NM). *J. Theor. Biol.;* **51**: 313-335(1975).

A mathematical theory of hapten inhibition of hemolytic plaque formation is presented. The treatment is based upon the mathematical model for plaque growth presented by DeLisi and Bell (1974). The lymphocyte under consideration is embedded in an infinite three-dimensional medium, and is secreting antibodies isotropically at a constant rate. As the antibodies diffuse from the source they can bind reversibly to hapten, and in the most general case reversibly to red blood cell (RBC) epitope. The model leads to a non-linear diffusion equation coupled to a set of first order differential equations. The system must, in general, be solved numerically. However, in many cases of experimental interest simplifications arise which permit closed form solutions to be obtained. Solutions for three special cases were developed. The theory predicts that the type of information one can obtain from inhibition experiments depends critically upon the preparation of the RBC. If the cell is sufficiently haptenated so that rapid irreversible multivalent attachment is favorable, a differential plot of the inhibition curve will reflect the affinity distribution of antibody sites for free hapten. If only univalent attachment with RBCs is possible, so that antibody sites bind to RBC hapten in the same way they bind to free hapten, then a differential plot of the inhibition curve will reflect the secretion rate distribution. (auth)

5744 Abnormalities of chromosome 1 in myeloproliferative disorders. Rowley, J.D. (Univ. of Chicago). *Cancer;* **36**: No. 5, 1748-1757(Nov 1975).

Three patients with myeloproliferative disorders showed a similar chromosome abnormality, accompanied by other abnormalities that were different in each case. Marrow cells from all three patients were trisomic either for the entire chromosome 1 or for its long arm. Patient 1 had a brief period of anemia and thrombocytopenia which preceded a terminal acute leukemia; Patient 2 had polycythemia vera (P.V.) that terminated in acute leukemia; and Patient 3 had P.V. The detection of an abnormal karyotype in Patients 1 and 2 was an important factor in establishing the diagnosis of acute leukemia. Preliminary evidence supports the suggestion that some chromosomal changes are nonrandom in myeloproliferative diseases. Nonrandom abnormalities involving the same chromosome have been observed in several human neoplastic disorders. (auth)

5745 Ultrasonic parameters of freshly frozen dog tibia. Adler, L.; Cook, K.V. (Oak Ridge National Lab., TN). *J. Acoust. Soc. Am.;* **58**: No. 5, 1107-1108(Nov 1975).

Some experiments using ultrasonic wave propagation in freshly frozen dog tibia are reported. Longitudinal velocity measurements indicate significant directional variations. Absorption measurements resulted in a linear relationship between absorption coefficient and frequency. Shear velocity has also been measured in bones. (auth)

5746 Advanced technology for the clinical laboratory. Scott, C.D. (Oak Ridge National Lab., TN). *Fed. Proc.;* **34**: No. 12, 2127-2130(Nov 1975).

Developments in clinical laboratory technology that have the potential to provide "spin-offs" for other areas are reviewed. Activities in two areas are typical of this type of development: (1) technology that may be of use to specialized health care such as emergency services or remote facilities; and (2) new systems for the automation and analysis of large numbers of indicators of abnormality not previously available on routine basis. The paper specifically discusses centrifugal fast analyzers and high resolution multivariant analytical systems. (JWP)

5747 Block to multiplication of adenovirus serotype 2 in monkey cells. Klessig, D.F.; Anderson, C.W. (Cold Spring Harbor Lab., NY). *J. Virol.;* **16**: No. 6, 1650-1668(Dec 1975).

The block to adenovirus 2 (Ad2) multiplication in monkey cells can be overcome by coinfection with simian virus 40 (SV40). To identify this block we have compared the synthesis of Ad2

proteins in monkey cells infected with Ad2 alone (unenhanced) or with Ad2 plus SV40 (enhanced). Synthesis of viral proteins in enhanced cells was virtually identical to that found for permissive infection of human cells by Ad2 alone. In contrast, the unenhanced cells were strikingly deficient in the production of the IV (fiber) and 11.5K proteins whereas the synthesis of 100K and IVa_2 was normal. Synthesis of a number of other proteins such as II, V, and P-VII was partially reduced. A similar specific reduction in synthesis of these proteins was found when their messages were assayed by cell-free translation. This result suggests that the block to Ad2 protein synthesis is at the RNA level rather than with the translational machinery of monkey cells. Analysis of the complexity and the concentration of Ad2-specific RNAs, using hybridization of restriction endonuclease fragments of the Ad2 genome to increasing concentrations of RNA, shows that although all species of late Ad2 mRNA are present, the concentration of several species is reduced sevenfold or more in unenhanced monkey cells as compared with enhanced cells. These species come from regions of the genome known to encode the deficient proteins. A model for the failure of adenovirus to multiply in monkey cells, based on abnormal processing of specific adenovirus messages, is presented. (auth)

5748 Absence of one component of spectrin adenosine triphosphatase in hereditary spherocytosis. Kirkpatrick, F.H.; Woods, G.M.; La Celle, P.L. (Univ. of Rochester, NY). *Blood;* **46**: No. 6, 945-954(Dec 1975).

The stimulation by calcium and magnesium of ATPase activity of isolated ghosts, of water-soluble protein (spectrin), and of residual vesicles, derived from normal erythrocytes and from hereditary spherocytes (H.S.), has been measured. The ATPase activity found in normal water-soluble protein (WSP) at low levels of calcium (0.1-2.0 mM) is essentially absent in H.S. water-soluble protein, but the ATPase activity with magnesium and with high levels of calcium (60 to 100 mM) is the same in H.S. and normal WSP. Compared to normal, H.S. ghosts have increased Mg^{2+}-stimulated activity. This increased activity is retained by the sedimentable vesicles (residue) after extraction of the ghosts with 0.025 mM EDTA. The Ca^{2+}, Mg^{2+}-ATPase associated with the calcium pump is not significantly different in H.S. (auth)

TRACER TECHNIQUES

5749 In vivo human pharmacodynamics of the psychodysleptic 4-Br-2,5-dimethoxyphenylisopropylamine labelled with ^{82}Br or ^{77}Br. Sargent, T.; Kalbhen, D.A.; Shulgin, A.T.; Braun, G.; Staufer, H.; Kusubov, N. (Univ. of California, Berkeley). *Neuropharmacology;* **14**: 165-174(1974).

The psychodysleptic compound 4-Br-2,5-dimethoxyphenylisopropylamine (4-Br-DPIA) was synthesized with ^{82}Br or ^{77}Br and administered to five human subjects in three oral and three intravenous experiments. In vivo organ concentrations were measured by gamma ray scintigraphy with computerized area integration, and by whole-body counting. Urine was analyzed by solvent separation, and thin layer chromatography of dansylated metabolites. The urine contained less than 5 percent radiobromine precipitate by acidic $AgNO_3$, demonstrating that the Br label remained organically bound. Upon intravenous administration radioactivity appeared immediately in the lungs by first-pass extraction, was rapidly released and reached maximum concentrations in the liver at 0.5 to 1.5 hr, plasma at 2 to 3 hr and brain at 3 to 6 hr. Orally the pattern was the same except that the initial lung concentration did not occur. This sequence of maximum organ concentrations suggests that a metabolite of 4-Br-DPIA is the centrally active compound which concentrates in the brain. Solvent separation of urine showed 81.8 percent of metabolites to be aqueous soluble and 12.5 percent free base; slower whole-body excretion correlated with higher levels of free base in the urine. The methods used demonstrate a new approach to the study of in vivo distribution and kinetics of drugs which can be labelled with gamma-emitting radioisotopes. (auth)

5750 Developments in digital computer implementation in nuclear medicine imaging. Budinger, T.F. (Univ. of California, Berkeley); Harpootlian, J. *Comput. Biomed. Res.;* **8**: 26-52(1975).

The usefulness of a digital computer system for acquisition, manipulation and display of nuclear medicine or other medical two-dimensional images is enhanced by fast data acquisition of 80,000 cps in list mode (128 x 128) and 300,000 cps in histogram mode (64 x 64) with 3 μsec pulse pair resolution and dual isotope handling capabilities. Speed and ease of operation are important developments which lead to practical clinical application of research developments such as brain and heart blood-flow studies, Fresnel hologram reconstruction, three-dimensional reconstruction from multiple camera views, and display of functional images such as lung, heart, and kidney uptake and clearance rates. (auth)

MICROBIOLOGY

5751 (JUL—1036-PC) MICH: a program for the investigation of the behavior of microorganisms in a chemostat and consideration on inlet kinetics. Schleser, G.; Hanson, J.; Foerstel, H. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Physikalische Chemie). Dec 1973. 48p. (In German). Dep. NTIS (US Sales Only) $5.00.

A computer program was developed for the observation of the behavior of microorganisms in a chemostat. With it the total spectrum of curves with respect to a given strain (density of the microorganisms, doubling time, concentration of the limiting nutrient solution as a function of the dilution rate) can be calculated and plotted. With this program it is also possible by variation of given constants to simulate the saturation constants of various microorganisms or by variation of the initial conditions in a given chemostat to determine the most favorable conditions for the microorganisms present. The principles used in the development of the program are outlined and an example of its use is given. (JSR)

5752 Minicell production and bacteriophage superinducibility of thymidine-requiring strains of Haemophilus influenzae. Sedgwick, B.; Setlow, J.K.; Boling, M.E.; Allison, D.P. (Brookhaven National Lab., Upton, NY). *J. Bacteriol.;* **123**: No. 3, 1208-1217(Sep 1975).

Aminopterin- or trimethoprin-resistant thymidine-requiring strains of Haemophilus influenzae produce minicells, and the ratio of minicells to cells increases during the stationary phase of growth. Strain LB11, isolated after mutagenesis of a thymidine-requiring strain (Rd thd), produces more minicells than the parent strain. The mutations involved in high frequency minicell production have been transferred into the wild type (strain Rd) by transformation. The thymidine requirement in the resulting strain, MC1, is essential for minicell production, since spontaneous revertants of MC1 to prototrophy do not produce minicells. The ratio of minicells to cells was increased more than 10^3-fold by differential centrifugation. The minicells contain little or no deoxyribonucleic acid (DNA). Phage HP1cl apparently cannot attach to minicells. Competent cells of LB11 and its thymidine-requiring parent strain produce defective phage as a result of exposure to transforming DNA, whereas only LB11 produces many defective phage in response to the competence regime alone. Competent HP1cl and S2 lysogens of MC1 and Rd thd are also superinducible by transforming DNA, but competent LB11 lysogens produced about the same amount of HP1cl or S2 phage with or without exposure to transforming DNA possibly because of competition between the induced defective phage and Hp1cl or S2 phage. (auth)

5753 Autoradiography and immunofluorescence combined for autecological study of single cell activity with Nitrobacter as a model system. Fliermans, C.B.; Schmidt, E.L. (Univ. of Minnesota, Minneapolis). *Appl. Microbiol.;* **30**: No. 4, 676-684(Oct 1975).

Specific detection of a particular bacterium by immunofluorescence was combined with estimation of its metabolic activity by autoradiography. The nitrifying bacteria Nitrobacter agilis and N. winogradskyi were used as a model system. Nitrobacter were incubated with $NaH^{14}CO_3$ and $^{14}CO_2$ prior to study. The same preparations made for autoradiograms were stained with fluorescent antibodies specific for Nitrobacter species. Examination by epifluorescence and transmitted dark-field microscopy revealed Nitrobacter cells with and without associated silver grains. Direct detection and simultaneous evaluation of metabolic activity of Nitrobacter was demonstrated in pure cultures, in a simple mixed culture, and in a natural soil. (auth)

5754 Characterization of an inhibitor causing potassium chloride sensitivity of an RNA polymerase from T4 phage-infected Escherichia coli. Stevens, A.; Rhoton, J.C. (Oak Ridge National Lab., TN). *Biochemistry;* **14**: No. 23, 5074-5079(18 Nov 1975).

The nature of the inhibition by salt (KCl) of DNA-dependent RNA polymerase from T4 phage-infected Escherichia coli (T4 enzyme) was studied using holoenzyme preparations, core enzyme and sigma fractions. Salt inhibits formation of rifampicin-resistant preinitiation complexes. The inhibition was considerably reduced when a nonionic detergent (particularly of the Triton series) was included in the reaction mixtures. With T4 core enzyme and T4 sigma fractions together with the same fractions from uninfected cells (host enzyme fractions) and different DNA templates, we showed that the T sigma fraction plays a role in the salt-sensitive activity with T4 DNA. The salt sensitivity of the T4 sigma fraction was antagonized by Triton. The T4 sigma fraction inhibited the activity of host sigma when they were present together in reaction mixtures, particularly in the presence of salt. T4 sigma further purified by centrifugation in glycerol gradients had the same properties as the cruder fraction, and the T4-specific polypeptide of mol wt 10000 was found in the same fractions. If

the glycerol gradients contained 6 M urea, the mol wt 10000 polypeptide was separated from the salt-stimulated sigma. Fractions containing the small polypeptide could be added back to produce the salt-inhibitory effects. The inhibitory activity of both the crude sigma fraction and the fractions containing the small polypeptide was inactivated at 65°C. Results suggest that the mol wt 10000 protein is a salt-promoted inhibitor, but the small amounts present in purified fractions of the T4 enzyme have not allowed isolation in large enough quantities to permit a detailed study of its properties. (auth)

5755 Membrane location of a deoxyribonuclease implicated in the genetic transformation of Diplococcus pneumoniae. Lacks, S.; Neuberger, M. (Brookhaven National Lab., Upton, NY). *J. Bacteriol.*; **124**: No. 3, 1321-1329(Dec 1975).

The cellular localization of enzymes in Diplococcus pneumoniae was examined by fractionation of spheroplasts. A deoxyribonuclease implicated in the entry of deoxyribonucleic acid (DNA) into the cell during genetic transformation was located in the cell membrane. This enzyme, the major endonuclease of the cell (endonuclease I), which is necessary for the conversion of donor DNA to single strands inside the cell and oligonucleotides outside, thus could act at the cell surface. Another enzyme, the cell wall lysin (autolysin), was also found in the membrane fraction. Other enzymes, including amylomaltase, two exonucleases, an adenosine triphosphate-dependent deoxyribonuclease, and a restriction type endonuclease, were located in the cytosol within the cell. None of the enzymes examined were predominantly periplasmic in location. Spheroplasts were obtained spontaneously on incubation of pneumococcal cells in concentrated sugar solutions. The autolytic enzyme appears to be involved in this process. Cells that were physiologically competent to take up DNA formed osmotically sensitive spheroplasts two to three times faster than cells that were not in the competent state. Although some genetically incompetent mutants also formed spheroplasts more slowly, other such mutants formed them at the faster rate. (auth)

5756 Induction of petite mutations during germination and outgrowth of Saccharomyces cerevisiae ascospores. Redshaw, P.A. (Illinois State Univ., Normal). *J. Bacteriol.*; **124**: No. 3, 1411-1416(Dec 1975).

The germination and outgrowth of Saccharomyces cerevisiae ascospores were studied by determining the sensitivity of the ascospores to the action of chemical mutagens. Survival of the ascospores after N-methyl-N'-nitro-N-nitrosoguanidine (MNNG) treatment was low during the first 2 h of germination and then increased and remained constant. Survival of the ascospores after 2-methoxy-6-chloro-9-(3-[ethyl-2-chloroethyl]aminopropylamino)acridine . 2HCl (ICR-170) treatment was constant from 0 to 5 h, but as the ascospores completed outgrowth at 6 h they became more sensitive to killing by ICR-170. Survival of the ascospores remained high during treatment with 2-methoxy-6-chloro-9-(3-[ethyl-2-hydroxyethyl]aminopropylamino)acridine . 2HCl (ICR-170-OH) or 2,7-diamino-10-ethyl-9-phenyl-phenanthridinium bromide. The main classes of mutations screened for were petites and auxotrophs. The induction of petites and auxotrophs by MNNG was independent of the stage of germination and outgrowth treated. Petite induction by ICR-170 was dependent upon the stage of germination and outgrowth treated. The early hours of germination (0 to 3 h) were not sensitive to petite induction. However, there was maximal petite induction at 5 h into germination and outgrowth, followed by a decline. During this same time period, ICR-170 induced less than 1 percent auxotrophic colonies. This finding is very unusual because ICR-170 induced 15 percent auxotrophic colonies in starved log-phase cultures of S. cerevisiae. The acridine ICR-170-OH induced no mutations during germination and outgrowth of the ascospores. Ethidium bromide induced petites, and the petite frequency became maximal at 5 h of germination and outgrowth, a result similar to that obtained with ICR-170. (auth)

5757 Electron-transferring flavoprotein of Peptostreptococcus elsdenii that functions in the reduction of acrylyl-Coenzyme A. Brockman, H.L.; Wood, W.A. (Michigan State Univ., East Lansing). *J. Bacteriol.*; **124**: No. 3, 1447-1453(Dec 1975).

In Peptostreptococcus elsdenii, a three-component flavoprotein electron transfer system catalyzes the oxidation of lactate and the reduction of crotonyl-coenzyme A(CoA). Spectral evidence showed that D-lactate dehydrogenase, when reduced by D-lactate, was able to reduce butyryl-CoA dehydrogenase but only in the presence of the electron-transferring flavoprotein. Reduced nicotinamide adenine dinucleotide could replace reduced D-lactate dehydrogenase. A reconstituted system, containing the three partially purified enzymes, excess D-lactate, and a limiting amount of crotonyl-CoA, reduced the crotonyl-CoA to butyryl-CoA, but only if all components were present. The electron-transferring flavoprotein activity, purified 22-fold, was separated into two major flavoprotein components, A and B, after polyacrylamide gel electrophoresis. Elution of the proteins and subsequent kinetic assays of the eluates showed that component B catalyzes the reduction of butyryl-CoA dehydrogenase by reduced D-lactate dehydrogenase, whereas component A does not. Both A and B catalyzed the reduction of butyryl-CoA dehydrogenase by reduced nicotinamide adenine dinucleotide. The results suggest that the D-lactate dehydrogenase-dependent reduction involves a heretofore unrecognized component of the electron-transferring protein group which may utilize an unusual flavin, 6-hydroxy-7,8-dimethyl-10-(ribityl-5'-adenosine diphosphate)-isoalloxazine. (auth)

5758 D-lactate dehydrogenase of Peptostreptococcus elsdenii. Brockman, H.L.; Wood, W.A. (Michigan State Univ., East Lansing). *J. Bacteriol.*; **124**: No. 3, 1454-1461(Dec 1975).

D-Lactate dehydrogenase has been purified to near homogeneity from Peptostreptococcus elsdenii. As isolated, the enzyme contains flavine adenine dinucleotide and a tightly bound metal cofactor. Inactivation by ortho-phenanthroline occurs in two steps and is partially blocked by D-lactate. Reactivation by divalent metal ions occurs, with divalent zinc being the most effective. When ferricyanide is used as the electron acceptor, D-lactate has an apparent $K_{0.5}$ of 3.3 M[0.46]; its binding is negatively cooperative with a Hill coefficient of 0.46. Replacement of ferricyanide by the other components of the electron transport system yields hyperbolic kinetics with an apparent K/sub m/ for D-lactate of 26 mM. The apparent K/sub m/ for ferricyanide is 2.2×10^{-4} M. Phosphate and pyrophosphate compounds stimulate the D-lactate:ferricyanide activity. These properties suggest that interaction of this enzyme with other electron transport proteins in the chain may enhance D-lactate binding and, hence, the rate of electron transport. (auth)

5759 Purification, new assay, and properties of Coenzyme A transferase from Peptostreptococcus elsdenii. Tung, K.K.; Wood, W.A. (Michigan State Univ., East Lansing). *J. Bacteriol.*; **124**: No. 3, 1462-1474(Dec 1975).

Coenzyme A (CoA) transferase from Peptostreptococcus elsdenii has been purified and crystallized, and some of its properties have been established. The work was facilitated by a newly developed coupled and continuous spectrophotometric assay in which the disappearance of added acrylate could be followed at 245 nm. The rate-limiting conversion of acetyl- and β-hydroxypropionyl CoA to acrylyl CoA by CoA transferase was followed by the non-rate-limiting conversion to β-hydroxypropionyl CoA by excess crotonase. Thus, a small priming quantity of acetyl CoA served to generate acrylyl CoA, which, by hydration, generated β-hydroxypropionyl CoA. This product then served to generate more acrylyl CoA in cyclic fashion. The net result was the CoA transferase-limited conversion of acrylate to β-hydroxypropionate. The purified transferase has a molecular weight of 125,000 and is composed of two subunits of 63,000 each, as determined by disc gel electrophoresis. Short-chain-length monocarboxylic acids are substrates, whereas dicarboxylic or β-ketocarboxylic acids are not. The reaction kinetics are typical of a ping-pong bi bi mechanism composed of two half reactions linked by a covalent enzyme intermediate. Incubation of the transferase with acetyl CoA in the absence of a fatty acid acceptor yielded a stable intermediate which, by absorption spectrophotometry, radioactivity measurements, reduction with borohydride, reactivity with hydroxylamine, and catalytic activity, was identified as an enzyme-CoA compound. Kinetic constants for CoA transferase are: final specific activity, 110 U/mg of protein corresponding to 1.38×10^4 μmol of acrylate activated per μmol of transferase; K/sub m/ for acrylate, 1.2×10^{-3} M; K/sub m/ for acetyl CoA (β-hydroxypropionyl CoA), 2.4×10^{-5} M. (auth)

MORPHOLOGY

5760 Effect of an increase in light intensity on the utilization of leaf primordia in Osmunda cinnamomea L. Jordan, E.H.; Kuehnert, C.C. (Syracuse Univ., NY). *Bot. Gaz. (Chicago)*; **136**: No. 3, 286-289(Sep 1975).

Bud histories, that is, alternating sequences of bud scales and leaf bases remaining on the stem of the fern, Osmunda cinnamomea L., were determined in order to investigate the effects of an abrupt increase in light intensity on leaf primordial utilization. Studies of these increases in light intensity were made on plants growing under natural conditions. Increase in light intensity occurred in 1965 at the site of a newly developed road and also in 1968 at the site of a selective logging operation. Following an increase in light intensity, there is an increase in leaf primordial utilization. This increase occurs in both the bud scale and leaf fractions of the set. That these increases come from a large reservoir of leaf primordia that were initiated several years prior to

their utilization indicates that they should be considered strictly as utilization events and not initiation events. Leaf initiation, however, increases as well. (auth)

PATHOLOGY

5761 (ORNL—5072, pp 175-201) **Carcinogenesis program.** Kenney, F.T. Nov 1975.

In Biology Division annual progress report for period ending June 30, 1975.

Progress is reported on research activities in the following fields: assay for respiratory carcinogenesis using transplanted tracheas; elution of carcinogen from carrier particle in respiratory tract of mice; tobacco smoke bioassay project; mechanisms of chemical carcinogenesis; carcinogenic activity of N-nitroso compounds; DNA damage and repair by 4-nitroguinoline-1-oxide in normal and Rauscher leukemia-virus-infected rat cell lines; murine leukemia virus infection of cultured cells; attempts to identify specific tyrosine aminotransferase polyribosomes; and others. (HLW)

5762 Factors influencing augmentation and/or acceleration of lymphoreticular tumors in mice by benzo(a)pyrene treatment. Veselinovitch, S.D.; Kyriazis, A.P.; Mihailovich, N.; Rao, K.V.N. (Univ. of Chicago). *Cancer Res.*; **35**: 1963-1969(Aug 1975).

The response of lymphoreticular tissues to a single i.p. injection of benzo(a)pyrene was studied in the first generation of C57BL/6J x C3HeB/FeJ F_1 and C3HeB/FeJ x A/J F_1 mice. Groups of 1-, 15-, and 42-day-old animals of both sexes received 75 or 150 μg of the carcinogen per g body weight. After a period of approximately 90 weeks, a high incidence (up to 43 percent) of reticulum cell sarcomas was observed in C57BL/6J x C3HeB/FeJ F_1 mice treated with benzo(a)pyrene at 42 days of age. Animals treated with carcinogen at younger ages had a lower incidence of reticulum cell sarcomas. Control animals of either strain that were killed at 90 weeks of age were basically free of lymphoreticular tumors, while those kept under observation up to 170 weeks developed these tumors in 24 percent (C57BL x C3H F_1) and 10 percent (C3H x A/J F_1), respectively. Studies revealed that the augmentation and/or acceleration of development of the lymphoreticular neoplasms and specifically reticulum cell sarcomas by benzo(a)pyrene was dependent upon the strain and sex of mice used and the age at which the animals were exposed to carcinogen. (auth)

5763 Adriamycin-induced chromosome aberrations in human fibroblasts. Newsome, Y.L. (Oak Ridge Associated Universities, Inc., TN); Littlefield, L.G. *J. Natl. Cancer Inst.*; **55**: No. 5, 1061-1064(Nov 1975).

Adriamycin (AM) induced chromosome lesions and cell division delay in human foreskin fibroblasts. Cells treated with 0.01, 0.03, and 0.05 μg AM/ml culture medium for 1 hour and evaluated 5 to 12 hours post treatment exhibited a wide spectrum of cytogenetic injuries, ranging from moderately damaged metaphases with predominantly simple chromatid-type lesions to heavily damaged metaphases with chromosome stickiness and fragmentation. In moderately damaged metaphases that could be scored for specific types of aberrations, we observed a paucity of chromatid exchanges and chromosome-type lesions even in cultures having a very high frequency of breakages. Further, the distribution of breaks among chromosomes within groups A-G appeared to be random, which suggested that the drug does not show breakage specificity in human fibroblasts. The number of heavily damaged metaphases increased with an increase in concentration of AM and with longer periods of recovery. (auth)

PHYSIOLOGICAL SYSTEMS

5764 (ORO—3329-11) **Regulatory mechanisms of eosinopoiesis, progress report.** (Duke Univ., Durham, N.C. (USA). Medical Center). 1975. 8p. Dep. NTIS $4.50.

Progress is reported on studies of the regulatory mechanisms for eosinopoiesis in rats. Data are included on estimations of phospholipase B content of eosinophils present in intestinal tissues, lungs, and blood of rats under various physiological conditions. (CH)

5765 Sezary syndrome cell: surface ultrastructural characteristics. Golomb, H.M.; Braylan, R.; Reese, C.; Variakojis, D.; Brynes, R.K.; Yachnin, S. (Univ. of Chicago). *Acta Haematol.*; **54**: 106-114(1975).

Peripheral blood mononuclear cells from a patient with Sezary syndrome which lacked E-rosette-forming ability and surface immunoglobulins, and which displayed a markedly depressed response to a variety of mitogens, were studied by scanning electron microscopy (SEM) and transmission electron microscopy (TEM) on 3 occasions. The first peripheral blood sample (smooth) differed significantly from two later samples (moderate numbers of microvilli) when surface characteristics were examined by SEM; these differences were confirmed by TEM. The Sezary syndrome cells in this patient may be related to a T lymphocyte which has lost certain surface markers and mitogen response characteristics through a process of de-differentiation. (auth)

5766 Oogenesis in Xenopus laevis (Daudin). IV. Effects of gonadotropin, estrogen, and starvation on endocytosis in developing oocytes. Holland, C.A.; Dumont, J.N. (Oak Ridge National Lab., TN). *Cell Tissue Res.*; **162**: 177-184(1975).

The study was designed to explore the relationship of estrogen, human chorionic gonadotropin (HCG), and food availability to endocytosis in developing oocytes. When estrogen alone is administered to an animal, large amounts of vitellogenin are synthesized by the liver and secreted into the circulatory system, where it accumulates. Under these conditions there is no evidence of endocytosis at the surface of the oocytes. Other studies have shown that following HCG injection into estrogen-treated animals, vitellogenin is removed from the circulation and the oocyte surface is highly contoured and displays endocytotic activity. Food deprivation has much the same effect on oocyte endocytosis as does estrogen. When animals are given HCG and subsequently starved for 20 days, developing oocytes show little endocytotic activity. We conclude that HCG acts to promote or stimulate endocytosis in developing oocytes while estrogen and/or starvation inhibits this process. (auth)

5767 Uptake of ^{14}C-labed hydroxyanthranilic acid and enantiomers of tryptophan, kynurenine, and hydroxykynurenine in human blood. Hankes, L.V.; Schmaeler, M. (Brookhaven National Lab., Upton, NY). *Proc. Soc. Exp. Biol. Med.*; **149**: 1063-1068(1975).

Humans with scleroderma were studied to determine if observed differences in the metabolism of tryptophan metabolites were due to the rate of absorption of the D- vs. L-isomers or the ability of the enzymes present to use these isomers. Labeled enantiomers of tryptophan, kynurenine, and hydroxykynurenine were given to five patients with scleroderma. Blood samples were drawn periodically over a 24-hr period. When the D-isomers were given, peak blood levels of radioactivity did not appear until 8 hr, whereas with the natural L-isomers peak levels were reached in 2 hr. Considerable radioactivity was found firmly bound to the precipitated plasma proteins from both the L- and D-isomers. Incubation studies confirmed the binding of the D-isomers to the serum proteins. These experiments show that the use of pure labeled L-isomers is required, when studying the metabolism of amino acids in man, and that compounds other than L-tryptophan are bound to serum proteins in significant quantities. (JWP)

5768 Photochemical stimulation of nerves. Katz, J.J.; Janson, T.R. (to U.S. Energy Research and Development Administration). US Patent 3,900,034. 19 Aug 1975. Filed date 10 Apr 1974. 8p. PAT-APPL-459,756.

This invention relates to a method for stimulating a nerve or a severed nerve by placing a low power laser, preferably a photodiode laser, near the nerve and irradiating the nerve with the output from the laser. An end organ response is elicited upon irradiation of the attached nerve fiber. The output from the laser is of a nondestructive intensity such that the nerve and the tissue surrounding the nerve are not injured. The photochemical stimulation of the nerve is enhanced by staining the nerve to be stimulated with a sensitive, vital stain prior to the laser irradiation of the nerve. (auth)

5769 Generation of cytotoxic T lymphocytes in vitro. VI. Effect of cell density on response in mixed leukocyte cultures. Fitch, F.W.; Engers, H.D.; MacDonald, H.R.; Cerottini, J.C.; Brunner, K.T. (Swiss Inst. for Experimental Cancer Research, Lausanne). *J. Immunol.*; **115**: No. 6, 1688-1694(Dec 1975).

Reexposure of day 14 murine mixed leukocyte culture (MLC) populations to the original irradiated allogeneic stimulating spleen cells has previously been found to result in the rapid generation of cytolytic T lymphocytes (CTL) associated with a net increase in cultured cell number. Under the experimental conditions used, day 5 MLC cells appeared unable to respond to the allogeneic stimulus. In order to characterize further the development of the potential for anamnestic reactivity during the course of MLC, C57BL/6 spleen cells were incubated with irradiated (1000 rads) DBA/2 spleen cells (primary MLC) for up to 3 weeks. At various time intervals after the onset of the primary MLC, the surviving cells were collected and reexposed, at varying cell concentrations, to irradiated DBA/2 spleen cells (secondary MLC). At

daily intervals thereafter, CTL activity was assessed using a quantitative ^{51}Cr-release assay system. A paradoxic effect of responding cell concentration on generation of CTL activity was observed; relatively greater increase in CTL activity was observed. This effect was more pronounced with responding cells reexposed to antigen after primary MLC for 20 days, but was observed even with normal cells. The apparent unresponsiveness of day 5 MLC cells to alloantigen restimulation could be overcome by simple dilution of responding cells. Cytotoxic activity at the time of restimulation with antigen seems to be a major factor determining the magnitude of the secondary response. Since intact cells bearing alloantigens are required for the generation of CTL in MLC, residual cytotoxic cells reduce the effective antigenic stimulus by destroying stimulating cells. (auth)

PUBLIC HEALTH

5770 (CONF-751031—1) **Use of mathematical models and systems analysis as guides for schistosomiasis control measures.** Jobin, W.R. (Puerto Rico Nuclear Center, San Juan). 9 May 1975. 41p. Dep. NTIS $5.25.

From International conference on schistosomiasis; Cairo, United Arab Republic (18 Oct 1975).

This working paper on mathematical models approaches the development of mathematical models for the transmission cycle of schistosomiasis by developing independent models for the snail population and for the mammalian host populations. These models operate on biological data from the animal species, and on simple data from the environment regarding temperature, food, habitat volume and shelter. The model of the snail population is used to examine several possible control strategies in reservoirs. It is proposed that the steps needed to improve these models include addition of the schistosome infection and verification of the additions with experimental data. The eventual goal is a complete model, developed step-by-step, and verifying each addition. Ecological and habitat control methods are discussed for engineering projects including manipulation of water levels in reservoirs, location of human housing and drainage of snail habitats. (auth)

5771 **International program for microwave exposure protection.** Michaelson, S.M.; Suess, M.J. (Univ. of Rochester, NY). pp 99-101 of In Microwave symposium. Gaylord, T.K. (ed.). New York; Institute of Electrical and Electronics Engineers, Inc. (1974).

From S-MTT international microwave symposium; Atlanta, Georgia, USA (12 Jun 1974).

See CONF-740610—.

In the developed countries there has been a remarkable increase in the number of processes and devices that utilize or emit microwaves during the last 25 years. Such devices are used in all sectors of our society for military, industrial, telecommunications, and consumer applications. Because of the world-wide implications of the rapidly developing technology and associated health safety considerations, development and implementation of a program for international cooperation in the use and protective measures related to microwave/radiofrequency exposure is required. Activity in this respect has been initiated by the Regional Office for Europe of the World Health Organization (WHO/EURO) which has developed a long term program concerned with the health effects of nonionizing radiations. To implement this program, several steps have been taken with participation by scientists and administrators from several countries. These activities have engendered plans and proposals for facilitating exchange and evaluation of information on the biologic and health effects of microwave radiation and in focusing attention on those areas in which additional information and new approaches are needed. (auth)

5772 **Thermogenetic and cardiodynamic regulation in dogs cranially exposed to 2450 MHz (CW) microwaves.** Lu, S.T.; Bogardus, R.; Cohen, J.; Jones, J.; Kinnen, E.; Michaelson, S.; Magin, R. (Univ. of Rochester, NY). pp 102-103 of In Microwave symposium. Gaylord, T.K. (ed.). New York; Institute of Electrical and Electronics Engineers, Inc. (1974).

From S-MTT international microwave symposium; Atlanta, Georgia, USA (12 Jun 1974).

See CONF-740610—.

The cranial area of dogs was exposed dorsally to 2450 MHz (CW) microwaves at different power densities, while various temperatures (rectal, skin, jugular and tympanic), blood flows (pulmonary, renal and systemic circulation) and pressures (interventricular and systemic arterial) were simultaneously monitored. The preliminary results obtained provide a basis for comparison of the response of various organs to localized and whole-body exposure to microwaves. (auth)

5773 **Rapid digestion process for determination of trichinellae in meat.** Giles, P.M. (to U.S. Energy Research and Development Administration). US Patent 3,892,529. 1 Jul 1975. Filed date 1 Apr 1974. 4p.

PAT-APPL-456,995.

This patent relates to an accelerated digestion process for releasing trichinellae from meat (usually pork) as excysted and encysted worms in transparent fluid whereby they may be easily identified and/or counted visually or automatically. This improved digestion process for the determination of trichinellae in meat comprises placing the meat in a blender, adding a digestant consisting of one of the following ingredients, namely sodium hypochlorite, hydrochloric acid and pepsin, bromelin, trypsin, or dilute papain; and blending the meat and digestant for about one minute and then pouring the solution into a receptacle, allowing particulate to settle to the bottom, extracting samples from the bottom of said receptacle, and visually or automatically identifying and/or counting any trichinellae that may be present. (auth)

AGRICULTURE AND FOOD TECHNOLOGY

5774 (LA—6088-PR) **Passive electronic identification and temperature monitoring system. Progress report, July 1, 1974—June 30, 1975.** Koelle, A.R.; Bobbett, R.E.; Landt, J.A.; Sanders, W.M.; Holm, D.M.; Depp, S.W. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. Contract W-7405-ENG-36. 18p. Dep. NTIS $4.00.

The development to date of the electronic identification and temperature monitoring of animals indicates that an external transponder on the animals is feasible with a minimum amount of additional development. However, additional work needs to be performed to optimize and evaluate this system for subdermal implants. An implantable temperature-only transponder system with hybrid circuits in the transponder is under development and is scheduled for testing in the fall of 1975. Only favorable reactions to electronic identification have been received from livestock industry representatives. Continuous temperature measurements are being obtained to provide base-line data for determining the merits of temperature monitoring. Computer compilation of livestock movements and herd test records has been studied. The initial results are very encouraging. (auth)

5775 **Some observations on the cultivation of opium poppy (Papaver somniferum L.) for its latex.** Krikorian, A.D.; Ledbetter, M.C. (State Univ. of New York). *Bot. Rev.*; **41**: No. 1, 30-103(1975).

The cultivation of opium poppy for its latex is presented in some detail. Special emphasis is placed on agricultural and production practices as they exist today in India and Turkey. Traditional techniques as employed in Iran are outlined but the details of current practices must await further study. An attempt is also made to discuss briefly the cultivation of opium poppy and the harvesting of its latex as it relates to Afghanistan, Pakistan, Thailand and China. (auth)

5776 **Isotope effects in relation to the interpretation of $^{15}N/^{14}N$ ratios in tracer studies.** Edwards, A.P. (Univ. of Nebraska, Lincoln). pp 455-468 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

Data from aerobic incubation studies involving application of ^{15}N-depleted, ^{15}N-enriched and natural-abundance aqua-ammonia fertilizer to a Webster soil have been used to calculate the change in isotope concentrations produced by isotope effects acting on the portion of the fertilizer ammonium converted to nitrate. The nitrate-N from the fertilizer sources contained significantly more ^{15}N than the ammonium-N applied, which is exactly opposite to the result to be expected in a pure system where ammonium is undergoing partial nitrification only. A model to explain these results, and to illustrate the probable sequence of changes in cropped soils, is presented. The significance of isotope effects with respect to the interpretation of $^{15}N/^{14}N$ ratios actually measured during tracer investigations is greatest where an attempt is made to use the natural-abundance approach to quantitative separation of sources. The possibility of using small changes in isotope concentration to elucidate soil reaction mechanisms is shown to be extremely unlikely because partial conversions of unknown magnitude are the rule rather than the exception in soils. (auth)

TRACER TECHNIQUES

5777 Field measurements of N-utilization efficiency and nitrate movement in soils using ^{15}N-depleted fertilizer. Broadbent, F.E. (Univ. of California, Davis). pp 373-382 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

A field experiment consisting of 48 plots on Yolo fine sandy loam was set up with 4 levels of fertilizer, 0, 90, 180, and 360 kg N/ha applied as $(NH_4)_2SO_4$ containing less than 0.003 at. percent ^{15}N. Three irrigation regimes equivalent to 1/3, 3/3, and 5/3 of the normal evapotranspiration (ET) curves for maize at this location were used. Isotopic composition of components of the maize crop was very uniform at a given fertilizer level. Efficiency of fertilizer N uptake by the crop ranged from 33 percent at the 360 kg level to 53 percent at the 90 kg level. Analysis of soil solutions at various depths in the soil over the season showed that very little fertilizer-derived nitrate moved below the root zone unless both fertilizer level and amount of water applied was excessive. (auth)

5778 Measurement of water and nitrogen fluxes in soil profiles planted to maize. Biggar, J.W.; Nielsen, D.R.; MacIntyre, J.L. (Univ. of California, Davis). pp 417-428 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

A field experiment to study the flux of water and nitrogen from the root zone of maize during growth and the following fallow period is described. The experiment includes four rates of fertilizer applied as ^{14}N in ^{15}N-depleted NH_4SO_4, and three irrigation regimes. Tensiometers for measuring soil water pressure, neutron probes for measuring soil water content and suction probes to obtain soil solution samples are located in the experimental area. Water is supplied by sprinkler irrigation. Results demonstrate the responsiveness of the instruments and the wide differences in water movement out of the root zone. Nitrogen losses are largest under the wettest treatment although very little of the N lost appears to have been derived from the fertilizer applied at the beginning of the experiment. The fate of nitrogen in the Soil-Water-Plant system is partially controlled by the behaviour of the water in the soil. Previous work has shown that the soil water content and the soil water flux must be considered when accounting for microbial transformations, movement of nitrogen in the soluble and gaseous forms, mixing of solutes in homogeneous and non-homogeneous soil profiles and transport of this nitrogen out of the root zone and the extraction of nitrogen by plants. (auth)

5779 Measurement system for total nitrogen and $^{15}N/^{14}N$ in plant tissue, soil, and water. Walker, R.L.; Walton, J.R.; Carter, J.A.; Matthews, D.R. (Oak Ridge National Lab., TN). pp 429-438 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The ability to follow the behaviour of nitrogen in environmental systems has led to the development of an analytical system which can measure the quantity and isotopic abundance of nitrogen in a variety of samples. A reductive pyrolysis unit and a directional focusing 6-inch radius gas mass spectrometer were combined into the system. In the reductive pyrolysis part of the system, nitrogen species are converted to ammonia in an atmosphere of hydrogen in the presence of a heated nickel catalyst. A small amount (approximately 5 percent) of the resulting ammonia is directed into a cold finger reaction vessel where it is converted to nitrogen for isotopic analysis by mass spectrometry. The ammonia is decomposed thermally to nitrogen and hydrogen employing a rhenium filament heated to 1050°C. The nitrogen from the decomposition is used for measuring the abundance of masses 28 and 29; the ^{15}N abundance of masses 28 and 29; the ^{15}N abundance is calculated from the measured ratios. The system has been used to analyze vegetation and water samples with precisions of 0.5 per cent of the $^{15}N/^{14}N$ value at the normal isotopic range and 6 percent for the quantitative analysis. The minimum sample size required for a complete analysis is 20 μg of nitrogen. Three samples can be completed in an hour using multiple reaction vessels. (auth)

5780 Nitrogen isotope ratios in surface and sub-surface soil horizons. Rennie, D.A.; Paul, E.A. (Univ. of Saskatchewan, Saskatoon). pp 441-453 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

Nitrogen isotope analysis of surface soils and soil-derived nitrate for selected chernozemic and luvisolic soils showed mean delta ^{15}N values of 11.7 and 11.3, respectively. Isotope enrichment of the total N reached a maximum in the lower B horizon. Sub-soil parent material samples from the one deep profile included in the study indicated a delta ^{15}N value (NO_3-N) of $^1/_3$ that of the Ap horizon, at a depth of 180 cm. The delta ^{15}N of sub-surface soil horizons containing residual fertilizer N were low (-2.2) compared to the surface horizon (9.9). The data reported from this preliminary survey suggest that the natural variations in ^{15}N abundance between different soils and horizons of the same soil reflect the cumulative effects of soil genesis and soil management. More detailed knowledge and understanding of biological and other processes which control N isotope concentrations in these soils must be obtained before the data reported can be interpreted. (auth)

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

5781 (COO—3521-4) Chemical and biological studies on nucleic acids and derivatives. Progress report, October 1, 1974—April 30, 1975. Brown, G.B. (Sloan-Kettering Inst. for Cancer Research, New York (USA)). Oct 1975. Contract E(11-1)-3521. 26p. Dep. NTIS $4.50.

Ultraviolet irradiation of N-hydroxyxanthines in the solid state induces a radical that was assigned as an acyl amidogen radical in which the unpaired electron density is partially delocalized throughout the π-cloud of the purine ring. The radical is reduced in the presence of water. In the presence of methanol this process is also accompanied by some 8-substitution. Photochemical deoxygenation in solution was found to proceed from either the nonionized N-hydroxyl tautomer or the conjugate anion of N-hydroxypurines. Reduction is the sole photoreaction of the former, while intramolecular migration of the oxygen is the main photoprocess of the latter with photoreduction a minor result. The comparison of the photochemistry of the N-hydroxypurine anion to that of the corresponding purine N-oxide was documented with a study of suitable model purine 1-oxides. A unique photorearrangement of 1-hydroxyxanthine to the oncogenic 3-isomer was examined and is deduced to be a two step process. (auth)

IN MICROORGANISMS

5782 Degradation of DNA in Haemophilus influenzae cells after x-ray irradiation. I. Experimental results. Randolph, M.L.; Setlow, J.K. (Oak Ridge National Lab., TN). *Biophys. J.*; 15: No. 5, 441-453(May 1975).

Sequential measurements of DNA in Haemophilus influenzae cells after x-ray irradiation show rapid initial degradation of DNA followed by a plateau after about 40 min at normal growth conditions. Both the initial rate and final amount of degradation increase with radiation exposure. Degradation is somewhat greater in stationary-phase than in log-phase cells, but colony-forming ability (CFA) is independent of cell stage. Distributions of single-strand lengths of DNA in unirradiated or irradiated cases, as measured by alkaline sucrose gradient techniques, are neither monodispersive nor random, and possible causes for nonrandomness are discussed. (auth)

5783 Influence of the λ prophage on the action of the inducible inhibitor of postirradiation DNA degradation. Polland, E.C.; Randall, E.P.; Keller, K.M.; Boyce, R.P. (Pennsylvania State Univ., University Park). *Radiat. Res.*; 63: No. 3, 553-559(Sep 1975).

Early observations on the inducible inhibitor of postirradiation DNA degradation involved cells of Eschericia coli which carried either prophage or defective prophage. The question as to whether the prophage element is essential can be answered by observing the induction of inhibition in cells which (a) carry the prophage and can be induced or do not have the prophage and (b) carry the prophage but can not be induced. The strains used are AB1157 and AB1157γ/sub ref/; AB2463(recA$^-$) and AB2463γ /sub ref/; AB2494(lex$^-$) and AB2494γ/sub ref/. The results indicate that, while the presence of an inducible prophage does modify the postirradiation DNA degradation, it is not essential; in-

hibition occurs in its absence. On the other hand a prophage in a cell where induction is absent or minimal does not confer the property of inhibition. The inducible inhibitor is therefore a property with characteristics similar to phage induction but not the same as phage induction. (auth)

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

5784 Age response for line CHO Chinese hamster cells exposed to x irradiation and alpha particles from plutonium. Raju, M.R.; Tobey, R.A.; Jett, J.H.; Walters, R.A. (Los Alamos Scientific Lab., NM). *Radiat. Res.*; 63: No. 3, 422-433(Sep 1975).

The age response of Chinese hamster cells (line CHO) synchronized by mitotic selection and by mitotic selection with hydroxyurea resynchronization was studied for x rays and alpha particles from plutonium of 4.4-MeV residual energy. The age response for alpha particles when mitotically synchronized cells are used indicated that cells in S are slightly more sensitive but that the magnitude of variation is quite small. When cells were synchronized first by mitotic selection and then resynchronized by hydroxyurea, the variation of radiosensitivity as a function of cell cycle for x rays was found to be enhanced because of a higher degree of synchrony. In the case of alpha particles, it was found that cells in late S were more sensitive and that there was a clear peak of resistance corresponding to cells in G_2/early G_1. (auth)

INTERNAL SOURCE

5785 Cell killing by gamma rays and beta particles from tritiated water and incorporated tritiated thymidine. Bedford, J.S.; Mitchell, J.B.; Griggs, H.G.; Bender, M.A. (Vanderbilt Univ. Hospital, Nashville). *Radiat. Res.*; 63: No. 3, 531-543(Sep 1975).

With the use of two mammalian cell lines (L5178Y and V79), a comparison was made of the efficiency of cell killing by gamma rays and beta particles from tritiated water and incorporated tritiated thymidine. For the latter, cells were incubated with tritiated thymidine for one generation (unifilar labeling) or for four generations (bifilar labeling). To prevent cell division during exposures, irradiations were carried out with cells held in the frozen state or, in one case, at 5°C. There was no significant difference in cell killing efficiency for unifilar or bifilar modes of tritiated thymidine incorporation. In the frozen state an increase in D_0 was observed for all modes of irradiation, but an apparent increase in killing efficiency was observed for irradiations following incorporation of tritiated thymidine relative to that observed for irradiations with gamma rays. For cells irradiated at 5°C, the efficiency of cell killing by beta particles from tritiated water or incorporated tritiated thymidine was not appreciably different, but both were more efficient than gamma irradiation delivered under similar conditions. For killing of V79 cells at 5°C, and at a dose rate of 20 rad/hr, the relative biological effectiveness (RBE) of tritium beta particles relative to cobalt-60 gamma rays was estimated to be approximately 1.7 to 1.9. (auth)

RADIATION EFFECTS ON MICROORGANISMS

5786 (ORO—3941-24) Mechanisms of recombination and function of DNA in bacteria. Annual progress report, May 9, 1974—May 2, 1975. Guild, W.R. (Duke Univ., Durham, N.C. (USA). Dept. of Biochemistry). 1975. Contract AT(40-1)-3941. 12p. Dep. NTIS $4.00.

BASIC STUDIES

5787 (COO—3232-7) Molecular basis for the mutagenic and lethal effects of ultraviolet irradiation. Progress report, September 1, 1975—August 31, 1976. Grossman, L.; McCollum, E.V. (Johns Hopkins Univ., Baltimore, Md. (USA)). 1975. Contract AT(11-1)-3232. 28p. Dep. NTIS $5.00.

Progress is reported on studies on the lethal and mutagenic effects of ultraviolet radiation in Escherichia coli. The role of enzymes and genes controlling the repair of DNA damage is discussed. (CH)

5788 (SAND—75-5640) Thermoradiation treatment of sewage sludge to eliminate pathogens for safe use as fertilizer and animal feed supplement. Sivinski, H.D.; Whitfield, W.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 23p. (CONF-750967—12). Dep. NTIS $4.25.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

This paper describes a research program titled "Waste Resources Utilization" using a new technique called thermoradiation to destroy pathogenic organisms in sewage sludge. The thermoradiated sewage sludge will be used to study the feasibility of use for safe land application as fertilizer and soil conditioner and use as a feed supplement for ruminant animals. Experiments to date have shown good results for sludge disinfection of resistant bacteria, viruses, and parasites. Thermoradiation experiments are being carried out at a temperature of 65°C combined with 160 krad gamma dose for a total of 2000 pounds of dried treated sludge. The sludge will be shipped to New Mexico State University for the feeding studies and land application studies. (auth)

5789 DNA degradation in minicells of Escherichia coli K-12. II. Effect of recA1 and recB21 mutations on DNA degradation in minicells and detection of exonuclease V activity. Khachatourians, G.G. (Univ. of Saskatchewan, Saskatoon); Paterson, M.C.; Sheehy, R.J.; Van Dorp, B.; Worthy, T.E. *Mol. Gen. Genet.*; 138: 179-192(1975).

The properties of minicell producing mutants of Escherichia coli deficient in genetic recombination were examined. Experiments were designed to test recombinant formation in conjugal crosses, survival following uv-irradiation in cells, and the state of DNA metabolism in minicells. The REC^- phenotypes are unaffected by $min^+/^-$ genotypes in whole cells. In contrast to minicells produced by rec^+ parental cells, minicells from a recB21 strain have limited capacity to degrade linear, Hfr transferred DNA. The lack of a functional recA gene product, presumably involved in inhibiting the recBC nuclease action(s), permits unrestricted Hfr DNA breakdown in minicells produced by a recA1 strain. This results in an increase in TCA soluble products and in the formation of small DNA molecules that sediment near the top of an alkaline sucrose gradient. Unlike the linear DNA, circular duplex DNA from plasmids R64-11 or lambdadv, segregated into the minicells, is resistant to breakdown. By using in vitro criteria, and [^{32}P]-labelled linear DNA from bacteriophage T_7 for substrate, we found that the ATP- dependent exonuclease of the recBC complex (exo V) is present in rec^+ and $recA^-$ minicells, and is lacking in the recB21 mutant. In fact, the absence of a functional exo V in $recBC^-$ minicells results in isolation of larger than average Hfr DNA from minicells. We suggest that recombination (REC) enzymes segregate into the polar minicells at the time of minicell biogenesis. This system should be useful for studies on DNA metabolism and functions of the recBC and recA gene products. (auth)

RADIATION EFFECTS ON ANIMALS

MAN

5790 (AECL—5243) Cancer following multiple fluoroscopies. Newcombe, H.B. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Aug 1975. 37p. Dep. NTIS (US Sales Only) $5.00. AECL $1.00.

An epidemiological study for detecting carcinogenic effects of multiple fluoroscopies in Canadian tuberculosis patients, treated in the late 1930's to early 1950's when artificial pneumothorax was a standard procedure, is described. Intensive investigation of irradiated human populations has failed to yield an indication of the numbers of cancers likely to arise among very large numbers of people who have been exposed to very low doses of radiation. There are now very few irradiated human populations left for study. One irradiated population which has so far been studied on only a limited scale consists of persons who received artificial pneumothorax treatment for tuberculosis, in the course of which they were fluoroscoped repeatedly, usually once or twice at the time of each refill. In Canada, there were approximately 140,000 first admissions to tuberculosis institutions in the period from 1938 through 1954 and a substantial proportion of the relevant records are fortunately still in existence and available for study. Roughly half of the patients with pulmonary tuberculosis, in that period, received artificial pneumothorax. That breast cancer has been caused in women by the fluoroscopies seems clear from the results of preliminary studies, but the data have a number of important limitations for present purposes. These studies are unfortunately not large enough to indicate differences in the risks from various numbers of fluoroscopies. Also, unless the numbers of years at risk in the irradiated and unirradiated groups can be shown to be similar, there is a possibility of bias affecting the comparison. In addition, information on the numbers of malignancies other than breast cancer, in patients of both sexes, would be substantial importance even if no effect of the irradiations could be demonstrated. (auth)

5791 (BNL—50424) **Twenty-year review of medical findings in a marshallese population accidentally exposed to radioactive fallout.** Conard, R.A. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. Contract AT(30-1)-16. 154p. Dep. NTIS $6.25.

A summary is presented of results of medical examinations of inhabitants of the Marshall Islands during the 20-year period following the exposure of Rongelap people to radioactive fallout in 1954. The initial effect observed was β burns of the skin of some individuals. Few significant findings were observed during the subsequent 9-year period, although an increase in miscarriages and stillbirths among the exposed women was noted. In 1963 some thyroid abnormalities and growth retardation of some children were noted. (177 references). (CH)

5792 (ORNL-TM—5102) **Preliminry results of the 1975 international personnel monitoring survey.** Becker, K. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. 36p. Dep. NTIS $4.00.

About 70 detailed questions have been answered in mid-1975 by 83 personnel monitoring services in 33 countries, representing almost half a million, or approximately 28 percent, of the world's total radiation workers, as well as by 11 customers of U. S. commercial services. Extensive data are given on many questions regarding the current system in use, future plans, and experiences, for example on the type(s) of TLD, film and readout instrumentation; monitoring period; applications for extremity and environmental monitoring; advantages and disadvantages of various systems; R and D projects; experience with beta and neutron dosimetry; intentional fake exposures; lower and upper dose limits; recordkeeping; and reporting of the results. The larger services in the advanced countries lead in the transition from film to TLD. More than half of the radiation workers already wear TLDs, or will do so within about two years. Important unsolved problems are fast neutron monitoring and the low information content and high initial cost of TLD. The trend is towards large, centralized, automatic services and recordkeeping, with extensive computer use for evaluation and data handling. There is a need for better performance standards and testing, and more information exchange and cooperation between services. (auth)

5793 (SAAS—178) **Occupational radiation exposure in the GDR in 1971.** Koenig, W.; Larssen, A.; Rothe, W. (Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic)). May 1975. 42p. (In German). Dep. NTIS (US Sales Only) $5.00.

In 1971 a total of 32,843 occupationally exposed persons were monitored by the central film badge service of the National Centre for Radiation Protection. The monthly over-exposures (more than 0.4 rad) totalled 685. In 40 cases the quarterly dose (3 rad) was exceeded during one month and 12 of these records could be assessed as real over-exposures. Most of the over-exposures could be attributed to an insufficient application of safety regulations. The results were analyzed according to type of institution and type and duration of employment as well as age of employees. (auth)

5794 **Cervical synovial sarcoma at the bifurcation of the carotid artery.** Golomb, H.M.; Gorny, J.; Powell, W.; Graff, P.; Ultmann, J.E. (Univ. of Chicago). *Cancer;* **35**: No. 2, 483-489(Feb 1975).

5795 **Induction of chromosomal aberrations in human lymphocytes by x rays and fission neutrons: dependence on cell cycle stage.** Carrano, A.V. (Univ. of California, Livermore). *Radiat. Res.;* **63**: No. 3, 403-421(Sep 1975).

Human lymphocytes were irradiated in culture with several doses of 250 kVp x rays or fission neutrons (0.85 MeV average energy) either in the unstimulated state (G_0), at 17 hr after phytohemagglutinin stimulation (G_1), or at approximately 48 hr after stimulation. In the last case, the cells were labeled with tritiated thymidine prior to irradiation to distinguish S and G_2 cells. All cultures were harvested at two successive intervals between 48 and 58 hr. The frequencies of neutron-induced chromatid deletions in G_2 cells differed significantly among harvest times and definite trends were observed for other aberrations. Dose-response curves for chromosome type aberrations followed the classical aberration production model; chromatid aberrations exhibited more complex kinetics. The differential cell cycle response to aberration induction varied with radiation quality, dose, and aberration type. The relative biological effectiveness of fission neutrons for aberration production also varied with aberration type, cell cycle stage, and neutron dose but remained principally between 2 and 6. (auth)

5796 **Sites of unscheduled DNA synthesis within irradiated human lymphocytes.** Berliner, J.; Himes, S.W.; Aoki, C.T.; Norman, A. (Depts. of Pathology and Radiological Sciences, Los Angeles). *Radiat. Res.;* **63**: No. 3, 544-552(Sep 1975).

The sites of unscheduled DNA synthesis (UDS) induced by ultraviolet or ionizing radiations in human lymphocytes are not randomly distributed in the nuclear DNA. Examinations of radioautographs of 1.0-μm nuclear sections show that about 70 percent of the grains are over the 33 percent of the nuclear area adjacent to the nuclear membrane. This is found whether the bulk of the DNA, which is in heterochromatin masses, is peripherally distributed, is dispersed throughout the nucleus, or is homogeneously distributed. This peripheral distribution of UDS is maintained when incubation time is increased from 0.5 to 4 hr, and when cells are stimulated for 18 hr by phytohemagglutinin prior to irradiation. The distribution of UDS sites is not simply related to the distribution of euchromatin (active) or heterochromatin (repressed) within the nucleus. (auth)

5797 **Liver function in survivors of the atomic bomb.** Gregory, P.B.; Amamoto, K.; Archer, P.G.; Rickert, R.R.; Omori, Y.; Bizzozero, O.J. Jr.; Hamilton, H.W.; Johnson, K.G. (Atomic Bomb Casualty Commission, Hiroshima). *Radiat. Res.;* **63**: No. 3, 578-583(Sep 1975).

Screening liver function tests were obtained in survivors of the atomic bomb and matched nonexposed controls. Subjects with test values greater than two standard deviations from the mean received a detailed clinical evaluation. There was no evident long-term effect of exposure to the atomic bomb on liver function, detectable clinical liver disease, or hepatic histology. (auth)

VERTEBRATES

5798 (CONF-750671—2) **Radiobiologic effects at low radiation levels.** Casarett, G.W. (Rochester Univ., N.Y. (USA). School of Medicine and Dentistry). 1975. 14p. (UR—3490-832). Dep. NTIS $4.50.

From International symposium on areas of high natural radioactivity; Pocos de Caldas, Brazil (16 Jun 1975).

Data are reviewed on the effects of low radiation doses on mammals. Data from the 1972 report on the Biological Effects of Ionizing Radiation issued by the Advisory Committee of the National Academy of Sciences and National Research Council are discussed. It was concluded that there are certain radiosensitive systems in which low doses of radiation may cause degenerative effects, including gametogenic epithelium, lens of the eye, and developing embryos. Despite extensive investigation of genetic effects, including chromosomal effects, neither the amount of change that will be caused by very low levels of irradiation nor the degree of associated detriment is known. (CH)

5799 (CONF-751126—1) **Inter-species comparison of the responses of mice and dogs to continuous ^{60}Co γ-irradiation.** Norris, W.P.; Tyler, S.A.; Sacher, G.A. (Argonne National Lab., Ill. (USA)). Nov 1975. Contract W-31-109-Eng-38. 15p. (SM—202/524). Dep. NTIS $4.50.

From IAEA international symposium on biological effects of low level radiation pertinent to protection of man and his environment; Chicago, Illinois, USA (3 Nov 1975).

Young-adult, purebred, beagle dogs were exposed continuously, 22 hours/day, to ^{60}Co γ-rays until they died. The daily dose rates ranged from 3.5 to 210 rad. At 3.5 rad/day the mean survival time was in excess of 1860 days (the study is still in progress), while at 210 rad/day mean survival time was 13 days. The data are compared to those from previously published information from similarly irradiated mice. (CH)

5800 (COO—3267-08) **Radiation-induced chromosomal inversions in mice. Progress report, 1 June 1974—31 May 1975.** Bailey, D.W.; Womack, J.E. (Jackson Lab., Bar Harbor, Maine (USA)). 31 May 1975. Contract E(11-1)-3267. 16p. Dep. NTIS $4.50.

Progress is reported on studies of chromosomal inversions in the sperm of mice induced by irradiation or by a chemical mutagen. (CH)

5801 (COO—3267-09) **Radiation-induced chromosomal inversions in mice. Progress report, 1 June 1972—31 May 1975.** Bailey, D.W.; Womack, J.E. (Jackson Lab., Bar Harbor, Maine (USA)). 31 May 1975. Contract E(11-1)-3267. 9p. Dep. NTIS $4.50.

Progress is reported on studies of chromosomal inversions in the sperm of mice induced by irradiation or by a chemical mutagen. (CH)

5802 (LBL—4708) **Influence of cell dissociation procedures on the tumorigenicity of Simian Virus 40 transformed fibroblasts.** Tenforde, T.S.; Risius, J.; Beckmann, A.; Tobias, C.A.; Gurney, E. (California Univ., Davis (USA). Dept. of Engineering). Nov 1975. Contract W-7405-ENG-48. 15p. Dep. NTIS $4.00.

Mouse fibroblasts transformed by Simian Virus 40 (SV40) were examined for tumor forming ability in syngeneic BALB/c mice following dissociation from tissue culture dishes by two procedures. A significantly greater in vivo proliferative capacity was observed for cells dissociated by the tryspin-EDTA procedure, with the injected cell dose for tumor production in 50 percent of recipient mice (the TPD_{50}) being 16-fold lower than the TPD_{50} for cells dissociated by the EDTA procedure. Host immunosuppression with 300 rad whole-body γ irradiation led to a significant 7-fold decrease in the TPD_{50} for cells dissociated by the EDTA procedure, while no significant decrease in TPD_{50} was observed for cells dissociated by the tryspin-EDTA procedure. (auth)

5803 **Bone marrow regeneration after local injury: a review.** Patt, H.M.; Maloney, M.A. (Univ. of California, San Francisco). *Exp. Hematol.*; 3: 135-148(1975).

This paper is focused on a mechanically depleted medullary cavity as an experimental model for analysis of marrow regenerative programs. Mesenchymal cells form the characteristic marrow stroma. Hemic cell regeneration can occur without immigrant hematopoietic stem cells, although such cells are known to contribute to later stages of repopulation. The formation and resorption of trabecular bone appears to be intimately related to the development of a sinusoidal matrix, perhaps by serving as a callus or supporting lattice and perhaps by providing a mechanism for distribution of stromal progenitors. Hematopoiesis is initiated in sites of active bone resorption. The interplay of events consequent to marrow removal is strikingly similar to that seen with heterotopic marrow implants. Because stromal stem cells, unlike hematopoietic stem cells, do not migrate from distant sites, marrow stroma is the limiting factor in recovery from localized injury. Stromal stem cells are fairly radiosensitive but are not as sensitive as hematopoietic stem cells. The apparent radioresistance of stromal elements in an intact marrow seems to be due to their very low turnover rate. Latent radiation damage can be readily unmasked by conditions that promote their proliferation. This no doubt accounts for the radiosensitivity of stroma in an evacuated femur or heterotopic implant in contrast to its continued functional integrity with similar irradiation of in situ marrow. Even in an intact marrow, however, exposures in the 1000 rad range can lead to slowly evolving hypocellularity associated with diminished blood flow. With higher doses, aplasia of the irradiated site becomes progressively more generalized. It remains to be seen whether this limiting condition is due to the loss of specific regulatory functions of stromal components or merely reflects sinusoidal damage. (auth)

5804 **Response of the pronuclear mouse embryo to x irradiation in vitro.** FuFrain, R.J.; Casarett, A.P. (Cornell Univ., Ithaca, NY). *Radiat. Res.*; 63: No. 3, 494-500(Sep 1975).

Zygotes from superovulated hybrid C57BL/10J x SJL/J F_1 mice were flushed from the oviducts 24 hr after the HCG injection. Pronuclear stage embryos were selected, cultured, and observed for a total of six days in microdrops of a chemically defined medium at 37°C in an atmosphere of 90 percent nitrogen, 5 percent oxygen, 5 percent carbon dioxide. At 28 hr after the HCG injection, the late pronuclear stage embryos were irradiated at exposures ranging from 50 to 600 R using a 280 kVp Picker x-ray machine (80 R/min, 0.5 mm Cu + Al parabolic filters). As determined by logistic analysis of the survival data, the ED_{50} values were 757 +- 69 R for development to the two-cell stage and 126 +- 27 R for development to the expanded blastocyst stage. An analysis of the times of the first two cleavages following irradiation indicated a dose-dependent cleavage delay of 0.85 min/R in the second cleavage following late pronuclear irradiation from exposures up to 600 R. These experiments illustrate that immediate arrest of cleavage, delay in the subsequent cleavages, and failure to undergo initial differentiation all result from irradiation of the pronuclear zygote. Use of the in vitro culture system allows a precise quantification of the degree of radiation-induced cleavage delay. (auth)

5805 **Chromosome damage in liver cells from low dose rate alpha, beta, and gamma irradiation: derivation of RBE.** Brooks, A.L. (Inhalation Toxicology Research Inst., Albuquerque, NM). *Science*; 190: No. 4219, 1090-1092(12 Dec 1975).

Relative biological effectiveness (RBE) for chromosome damage in liver cells was determined after low dose rate exposures to alpha, beta, or gamma irradiation. Protracted exposures to beta and gamma irradiation were equally effective, whereas low dose rate exposures to alpha emitters were 15 to 20 times more damaging than exposures to beta or gamma irradiation. These data support the use of the quality factor of 10 recommended by the International Commission on Radiological Protection and the National Council on Radiation Protection for estimating the biological hazard from internally deposited alpha emitters. When the dose rates were low, all types of chromosome damage observed were produced by single-hit processes. (auth)

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

5806 (BNWL-SA—5550) **Microdosimetry of internal, particulate sources.** Roesch, W.C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 8 Sep 1975. Contract E(45-1)-1830. 17p. (CONF-751043—5). Dep. NTIS $4.50.

From Workshop on the biological effects and toxicity of Pu 239 and Ra 226; Sun Valley, Idaho, USA (6 Oct 1975).

The theory of microdosimetry is extended to include particulate and non-uniformly distributed sources typical of internally deposited radioisotopes. An example is presented in which stationary particulates of ^{239}Pu of negligible physical size are distributed at random in a tissue in which the sensitive sites are also assumed to be randomly distributed. Preliminary calculations are reported for this model of the probability density in specific energy of all the sites and of the fraction of sites in which no energy is deposited for particulates that emit between 1 and 100,000 alpha particles. (auth)

5807 (BNWL-SA—5588) **Calculated doses from inhaled transuranium radionuclides and potential risk equivalence to whole-body radiation.** Strom, P.O.; Watson, E.C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. 34p. (CONF-751105—16; SM—199/114). Dep. NTIS $5.00.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

The distribution of radiation dose commitments within the body that can result from the lung deposition of a number of transuranic radionuclides (^{237}Pu, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{243}Pu, ^{244}Pu, ^{241}Am, ^{242}Am, ^{243}Am, ^{244}Am, ^{242}Cm, ^{243}Cm, ^{244}Cm, and ^{246}Cm) was calculated. The variables that influence these organ dose commitments include the mobility of the particle or its dissolution products within the body, the radiation characteristics of the inhaled radionuclides and their progeny, and the size of the particles inhaled. In the calculation of organ dose commitments for whole-body, lungs, liver, bone tissues, kidneys, and gastrointestinal tract from the inhalation of transuranium radionuclides, physical characteristics of importance are the dimensions of the particle, its aerodynamic properties, and its density. For particles within the respirable size range, a useful description is provided by the activity median aerodynamic diameter. Dose commitments resulting from acute inhalation of plutonium, americium and curium nuclides relative to the activity median aerodynamic diameter (AMAD) were calculated using the computer program DACRIN. Deposition efficiencies were estimated for several regions of the respiratory tract as a function of the AMAD. These locations within the respiratory tract are described as the nasopharyngeal, the tracheobronchial, and the pulmonary regions. The deposition, migration, and retention of particles introduced into the respiratory tract are represented by descriptive mathematical models of these phenomena within the respiratory system. Estimates of the risk of excess deaths from cancer due to whole-body radiation doses are included in the calculations to provide an estimate of cancer death risks associated with the inhalation of transuranic compounds. These results are then equated to those from whole-body radiation doses. (CH)

5808 (CONF-751105—17) **Current status of the plutonium hot particle problem.** Richmond, C.R. (Oak Ridge National Lab., Tenn. (USA)). 1975. 12p. Dep. NTIS $4.50.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

Information now available on the question of lung irradiation from particulate plutonium is reviewed. Careful consideration of the available data shows that particulate plutonium is not more hazardous than the same amount of plutonium distributed uniformly. The data also suggest that the potential hazard from plutonium increases as the dispersion throughout the lung becomes more uniform. (CH)

ANIMALS

5809 (BNL—20599) **Genetic and hematopoietic effects of long-term tritiated water (HTO) ingestion in mice.** Carsten, A.L.; Cronkite, E.P. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 12p. (CONF-751126—7; SM—202/303). Dep. NTIS $4.50.

From IAEA international symposium on biological effects of low level radiation pertinent to protection of man and his environment; Chicago, Illinois, USA (3 Nov 1975).

The positive effects seen using the somewhat insensitive dominant lethal test system and the effects seen on the blood-forming cells indicates that at least in the mouse there is a hazard

in the continuous ingestion of HTO at a concentration of 3 μCCi/ml. A direct comparison of these results to the human drinking an equivalent amount of HTO is impossible due to the obvious differences in water metabolism between the two species. Until further experimentation at lower levels of ingestion are completed, it is difficult to comment concerning the significance of these results as related to current concepts of maximum permissible concentration. Studies are now underway examining the possible effects of lower concentrations of chronic HTO ingestion. (auth)

5810 (CONF-751126—6) **Response of the mouse fetus to radiation from Na/sup 99m/TcO_4.** Lathrop, K.A.; Gloria, I.V.; Harper, P.V. (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). 1975. Contract E(11-1)-69. 16p. (SM—202/416). Dep. NTIS $4.50.

From IAEA international symposium on biological effects of low level radiation pertinent to protection of man and his environment; Chicago, Illinois, USA (3 Nov 1975).

The element technetium has recently assumed ecological importance as a source of low-level radiation, with the use of /sup 99m/Tc in nuclear medicine and production of /sup 99m/Tc during generation of electricity by nuclear reaction. When technetium is introduced as pertechnetate into the blood stream of pregnant females, it is transported across the placental barrier to the fetus, where a portion appears to be incorporated into biomolecules. When combined as biomolecules, radionuclides that decay by electron capture or isomeric transition show a lethality greater than that predicted in cell cultures and radiation therapy. The decay of /sup 99m/Tc by isomeric transition, together with the other considerations, places a high priority on the investigation of its radiation effects due to clinical doses of up to 25 mCi. Female mice were given daily i.v. injections of 0, 5, 50, and 500 μ Ci of /sup 99m/Tc as pertechnetate in isotonic saline throughout gestation, gestation and lactation, or lactation. At two months of age, the progeny were mated with randomly selected litter mates to produce a second generation; the process was repeated with their progeny for production of the third generation.Preliminary results reinforce the existing concern about use of /sup 99m/Tc-pertechnetate in pregnant or potentially pregnant subjects. (auth)

5811 (LA-UR—75-1905) **Biological effect of focal alpha radiation on the hamster lung.** Smith, D.M.; Anderson, E.C.; Prine, J.R.; Holland, L.M.; Richmond, C.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1975. 12p. (CONF-751126—2). Dep. NTIS $4.50.

From IAEA international symposium on biological effects of low level radiation pertinent to protection of man and his environment; Chicago, Illinois, USA (3 Nov 1975).

Monodispersed 10-μm diameter ZrO_2 ceramic microspheres, containing varying amounts of $^{239}PuO_2$ or $^{238}PuO_2$, were injected into the jugular vein of 100-day-old Syrian hamsters. These biologically inert microspheres lodged subsequently in pulmonary capillaries and remained static in position throughout the life span of the animals with no discernible inflammatory response. The numbers of microspheres injected ranged from 2000 to 10,000 and the specific activity from 0 to 59 pCi/sphere so that the lung burdens were 0 to 354 nCi/animal. At these numbers, each plutonium-laden microsphere served as an independent, focal source of alpha radiation. No consistent alteration of life spans post-exposure was seen in the experimental hamsters compared to controls. Pulmonary tissue responses were minimal with only 0.5 percent of the animals given Pu/ZrO_2 microspheres ultimately developing primary tumors of the lung. No unexpected gross or histologic lesion were found in other major body tissues. (auth)

MICROORGANISMS

5812 (CONF-751034—1) **Damage to the DNA of microorganisms from decay of incorporated ^{125}I and the relationship of DNA damage to lethal effects.** Krisch, R.E.; Krasin, F.; Sauri, C.J. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 21p. Dep. NTIS $4.25.

From International conference on molecular and microdistribution of radioisotopes and biological consequences; Julich, F.R. Germany (2 Oct 1975).

Iodine-125 decays by electron capture and is known to cause severe molecular damage to small organic molecules via vacancy cascades. In an examination of the biological effects of this decay mode we have labelled coliphages T1 and T4, as well as E. coli, with ^{125}I-5-iododeoxyuridine, which is incorporated into DNA in place of thymidine. Labelled organisms are generally stored in liquid nitrogen at -196°C during decay and are periodically assayed for loss of viability and for breakage of DNA, using neutral and alkaline sucrose gradient sedimentation techniques. Briefly, our experiments have demonstrated drastic damage to DNA from the decay of incorporated ^{125}I, as would be predicted from the data for small molecules. (auth)

NUCLIDE KINETICS AND TOXICOLOGY

5813 **Biological effects of deuterium and other stable isotopes.** Lacroix, M.; Mosora, F. (Univ. Liege, Sart Tilman, Belgium). pp 383-387 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

Numerous review articles have already been published on the biological effects of deuterium. The most important of these effects are briefly recalled with special emphasis on the consequences of deuteriation on living organisms. The toxicity of low doses of deuterium is examined, particularly in the light of a hypothesis associating deuterium with ageing processes. The natural variations of deuterium concentration are considered in this connection. The use of the isotopic properties for modifying the pharmacological efficiency of various substances is also examined. In conclusion, the authors discuss the effects of two other stable isotopes, carbon-13 and oxygen-18. (auth)

MAN

5814 (BNWL-SA—5388) **Prediction of the health effects of inhaled transuranium elements from experimental animal data.** Bair, W.J.; Thomas, J.M. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 22p. (CONF-751105—14). Dep. NTIS $4.50.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

The purpose of animal experiments with transuranium elements is to provide information which can be used to predict the consequences of these alpha emitting elements for human health. However, scientific and technical groups have been hesitant to project from animal experiments to man. Since a human data base does not exist for inhaled plutonium it is necessary to extrapolate from animal experiments. In this report knowledge of the behavior of inhaled transuranium elements is reviewed with respect to clearance from lungs and spatial distribution within lungs. The current status of the relationship between lung cancer incidence and alpha radiation dose from inhaled transuranics is described. An estimate of risk obtained from the animal data is compared with a value derived from human data on radiation induced lung cancer and both are compared with the estimated cancer risk associated with the annual whole body dose limit of 5 rems for occupational exposure. The conclusion is that 15 rems per year to the lungs from transuranium elements is not a greater risk than 5 rem/year whole body exposure and may be less. (auth)

5815 (LA-UR—75-1610) **Uranium in the tissue of occupationally exposed workers.** Campbell, E.E.; McInroy, J.F.; Schulte, H.F. (Los Alamos Scientific Lab., N.Mex. (USA)). Apr 1975. 32p. (CONF-750445—7). Dep. NTIS $4.75.

From Conference on occupational health experience with uranium; Arlington, Virginia, USA (28 Apr 1975).

Data are presented on the content of uranium in tissue samples from deceased occupationally exposed uranium workers. Data on the distribution in lungs, lymph nodes, liver, kidneys, and bone tissues are correlated with available data on the urinary excretion of U during the period of occupational exposure. (CH)

5816 (LA-UR—75-1887) **Considerations in the assessment of plutonium deposition in man.** Voelz, G.; Umbarger, J.; McInroy, J.; Healy, J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 19p. (CONF-751205—4). Dep. NTIS $4.50.

From IAEA international seminar on diagnosis and treatment of incorporated radionuclides; Vienna, Austria (8 Dec 1975).

Data from human cases of plutonium inhalation are used to illustrate several important problems in the current methods of estimating plutonium body burdens. Individuals exposed to $^{238}PuO_2$ particles in a highly insoluble matrix showed an unusually slow rising urinary excretion curve over 300 to 400 days. In vivo chest counts during the first 6 months estimated lung burdens to be 10 to 30 nCi, but urinary excretion methods calculate residual systematic body burdens of 50 to 100 nCi at 1200 days after exposure. Current assumptions used in the in vivo calibration do not consider possible lung distribution of particulates soon after exposure that could alter the interpretation significantly. Tissue analysis of a lung from another case after recent inhalation exposure shows a significantly lesser concentration of plutonium in the subpleural region—the principal region of plutonium measurement by in vivo chest counting—as compared to distributions found years after exposure. Tissue analyses indicate that urinary excretion estimates of body burden over the long term tend to err on the high side up to

a factor of 5 or more. This procedure serves well for the purpose of protection of workers, but high estimates can lead to unnecessary job reassignments for the individual worker and can cause misleading conclusions when such data is used uncritically for reference in health effects studies. Additional research is needed to improve urinary excretion data analysis to reflect newer information derived from tissue data and to seek further understanding of the sources of variation in in vivo counting technology so it can be used with greater confidence. (auth)

ANIMALS

5817 (BNWL-SA—5456) **Aspects of inhaled DTPA toxicity in the rat, hamster and beagle dog and treatment effectiveness for excorporation of Pu from the rat.** Smith, V.H.; Ballou, J.E.; Lund, J.E.; Dagle, G.E.; Ragan, H.A.; Busch, R.H.; Hackett, P.L.; Willard, D.W. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 16p. (CONF-751205—6; SM—6/26). Dep. NTIS $4.50.

From IAEA international seminar on diagnosis and treatment of incorporated radionuclides; Vienna, Austria (8 Dec 1975).

After inhaling 1 to 4 HD (human dose equivalents, i.e., 1 g calcium trisodium N,N-bis (2-bis(carboxymethyl)amino) ethyl) glycinate/70 kg body weight) of Ca-DTPA rats and hamsters developed a transitory vesicular emphysema. This was not found in animals sacrificed later than 3 weeks after the last exposure. Dogs were anesthetised and administered Ca-DTPA aerosols via an intratracheal catheter for 30 min/day for 5 days. The average dose/exposure was 4 HD. One week following the last exposure, 3/4 treated dogs and 0/2 dogs exposed to saline aerosols showed enlargement and submucosal lymphoid follicles in the pyloric region of the stomach; this was not present in dogs sacrificed at 4, 8 or 18 weeks postexposure. Epithelial atypia in the alveolar lining was noted in 5/16 dogs inhaling Ca-DTPA and in 1/8 dogs exposed to saline aerosols, and may or may not be treatment-related. Rats receiving 1.2 μCi $^{238}Pu(NO_3)_4$ intramuscularly were treated promptly with 1.2 HD inhaled or intraperitoneally injected Ca-DTPA. The two methods of Ca-DTPA administration gave statistically identical Pu excorporation. Similar treatments initiated 8 months following the Pu injection also showed no effect of administration route. These experiments and implications for the safety and efficacy of inhaled Ca-DTPA as treatment for transuranic incorporations in man are discussed. (auth)

5818 (BNWL-SA—5464) **Development of a diagnostic model for inhaled promethium-147 oxide: animal studies.** Shipler, D.B.; Ballou, J.E.; Griffin, B.I.; Nelson, I.C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract AT(45-1)-1830. 19p. (SR—6/28; CONF-751205—). Dep. NTIS $4.50.

From IAEA international seminar on diagnosis and treatment of incorporated radionuclides; Vienna, Austria (8 Dec 1975).

Rats and beagle dogs were exposed by inhalation to an aerosol containing stable Sm_2O_3 tagged with $^{145}Sm_2O_3$ and $^{143}Pm_2O_3$. The animals were sacrificed at 0, 14 and 30 days post-exposure to compare the kinetics and translocation of ^{145}Sm and ^{143}Pm. Quantitative analysis for ^{145}Sm and ^{143}Pm in several tissues and excreta indicate that the two rare earth elements were mobilized and distributed similarly by the rats and dogs. Results indicate that within the error of the measurement technique, samarium acts as a carrier for promethium. The data also indicate that activities measured in fecal samples could be used to predict lung burdens of ^{147}Pm. At activity levels and sintering temperatures employed in the rat exposures, there was sufficient activity in urine samples to permit its use as an indicator of lung burdens of ^{147}Pm. At activity levels and sintering temperatures employed in the dog exposures, this was not the case. (auth)

5819 (CONF-751126—4) **Effectiveness of tritium and ^{239}Pu in producing chromosome aberrations in Chironomus riparius.** Blaylock, B.G.; Trabalka, J.R. (Oak Ridge National Lab., Tenn. (USA)). 1975. 7p. Dep. NTIS $4.50.

From IAEA international symposium on biological effects of low level radiation pertinent to protection of man and his environment; Chicago, Illinois, USA (3 Nov 1975).

The existing literature on relative biological effectiveness (RBE) indicates that the high linear energy-transfer (LET) α-radiation of ^{239}Pu is more effective in the production of cytogenetic effects in mammalian cells in tissue culture than are forms of low LET radiation. The frequency of chromosome aberrations produced in the salivary gland chromosomes of insects (Chironomus riparius) by the low-energy beta rays from tritium were compared with those produced by the α radiation from ^{239}Pu. (auth)

5820 (CONF-751205—7) **Retention of plutonium in mouse tissues as affected by antiviral compounds and their analogs.** Lindenbaum, A.; Rosenthal, M.W.; Guilmette, R.A. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 20p. Dep. NTIS $4.50.

From IAEA international seminar on diagnosis and treatment of incorporated radionuclides; Vienna, Austria (8 Dec 1975).

The chelating agent DTPA (diethylenetriaminepentaacetic acid) is an effective therapeutic substance for decorporation of extracellar monomeric plutonium in the mouse and dog, but is much less effective in removing intracellular polymeric plutonium (Pu-P). In the absence of effective therapy, this intracellular plutonium is long retained in the body, particularly in reticuloendothelial tissues like the liver. Our interest, therefore, turned to the development of adjunct substances capable of removing additional plutonium from the liver beyond that removable by DTPA alone. We showed that glucan, a yeast cell wall polysaccharide, is a useful adjunct to DTPA for removal of Pu-P from the mouse liver. Its toxicity, however, makes it a less than desirable drug for potential human use. Therefore, we initiated a search for more soluble (and presumably less hazardous) therapeutic agents similar to glucan, i.e., capable of adjunct action with DTPA. Of over 20 substances tested the most successful results were obtained with two antiviral, antitumor compounds, the pyran copolymers XA-124-177 and XA-146-85-2. These are condensation products of divinyl ether and maleic anhydride. Another analog, EMH-227, prepared by condensation of acrylic acid and itaconic acid, was similarly successful. Maximal removal of plutonium from mouse liver was obtained with a single intravenous (I.V.) injection of 10 to 90 mg/kg of pyran copolymer given 5 days after I.V. Pu-P administration. Although these doses increased splenic uptake of plutonium, a dose of 10 mg/kg produced a minimal increase in the splenic burden while producing maximal removal of hepatic plutonium. (auth)

5821 **Radionuclide ratios in agricultural and biological chains in the context of the problem of radioactivity protection of the environment.** Arkhilov, N.P.; Prister, B.S.; Romanov, G.N.; Sirotkin, A.N.; Ustinov, V.V.; Fedorov, E.A. (State Committee on Utilization of Atomic Energy, Moscow). pp 267-276 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975). (In Russian)

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

The results of experiments on the study of strontium-90 behaviour relative to stable calcium and the transition of radioactive strontium and caesium into animals under different conditions are reported. The dynamics of the variations of radionuclide ratios in agricultural production under radioactive fall-out effects is presented. The conditions for applying isotope ratios for the purpose of estimating radioactive levels in the environment are discussed. (auth)

5822 **Radioisotope concentration effect in biology: its consequences in the use of radioactive tracers.** Guillot, P. (EURATOM, Brussels). pp 327-342 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

Experiments with people inhaling mixtures of stable and radioactive senon (^{133}Xe) showed a radioisotope concentration effect (RICE): if, under the same conditions, various amounts of radioxenon mixed with a fixed amount of stable xenon are inhaled the whole-body activity (A/sub t/) of ^{133}Xe at any time t after inhalation is never proportional to the inhaled activity (I), as it should be on the hypothesis of identical behaviour of stable and radioactive xenon in the body. The experimental relationship can be described by a power function of the type: A/sub t/(I) = k I/sup r/, where the exponent r is less than 1, for all t. This RICE has two important consequences for using radioactive tracers in biology. These consequences were experimentally confirmed with rats inhaling radioxenon mixtures, and with tomato plants absorbing stable and radioactive caesium from solutions: for simultaneous intake of two radioisotopes of the same element, the bigger the concentration ratio of the two radioisotopes in the intake, the bigger the relative difference between the two biological retentions of these radioisotopes; for simultaneous intake of the radioisotope and the stable isotope of the same element under identical conditons, the biological absorption of the radioisotope may be different from the biological absorption of the stable isotope, the differences depending on the relative concentrations of the isotopes. (auth)

5823 **Intramuscular retention of UO_3 and UO_4.** Beiter, H.; Gibb, F.R.; Marrow, P.E. (Rochester Univ., NY). *Health Phys.*; **29**: No. 2, 273-277(Aug 1975).

5824 Metabolic studies with radiobismuth. I. Retention and distribution of ^{206}Bi in the normal rat. Russ, G.A.; Bigler, R.E.; Tilbury, R.S.; Woodard, H.Q.; Laughlin, J.S. (Memorial Sloan-Kettering Cancer Center, New York). *Radiat. Res.*; **63**: No. 3, 443-454(Sep 1975).

The retention of tracer doses of bismuth citrate in mature female rats indicated that there were three compartments which cleared exponentially. Two of these compartments were renal and accounted for 30 percent and 44 percent of the administered dose. The biological half-times of bismuth in these compartments were less than 30 min and 13 hr, respectively. The nonrenal compartment accounted for the remainder of the dose and its retention half-time was 122 hr. The major site of bismuth accumulation was in the kidney. Autoradiographs showed ^{206}Bi to be localized in the renal cortex. The kidney is shown to secrete ^{206}Bi into the urine and the renal extraction ratio is in excess of 0.92 for bismuth citrate. Whole-body scans at 24 hr do not reveal any other areas of concentration and demonstrate the applicability of this radionuclide as an imaging agent with conventional equipment. (auth)

5825 Enhanced plutonium absorption in iron-deficient mice . Ragan, H.A. (Battelle Pacific Northwest Labs., Richland, WA). *Proc. Soc. Exp. Biol. Med.*; **150**: No. 1, 36-39(Oct 1975).

The total body burden of plutonium 24 or 96 hr following a single gastric intubation was approximately fourfold greater in iron-deficient than in iron-replete mice. There was also a more rapid translocation of plutonium from soft tissues to bone in the iron-deficient mice by 96 hr after gavage. In the iron-replete group only liver concentrations of plutonium increased during the corresponding time period. (auth)

PLANTS

5826 (STI/PUB—382) **Isotope ratios as pollutant source and behaviour indicators. Proceedings of a symposium held in Vienna, 18—22 November 1974. Proceedings series.** (International Atomic Energy Agency, Vienna (Austria)). 1975. 497p. (In several languages). (CONF-741120—). IAEA $31.00.

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

Separate abstracts were prepared for the 34 papers presented at the conference. A final summary and author index are included. (HLW)

5827 Tritium behavior pattern in some soil-plant systems in a tropical environment. Soma, S.D.; Iyengar, T.S.; Sadarangani, S.H.; Vaze, P.K. (Bhabha Atomic Research Centre, Trombay, India). pp 195-210 of In Isotope ratios as pollutant source and behaviour indicators. Vienna; International Atomic Energy Agency (1975).

From Symposium on isotope ratios as pollutant source and behavior indicators; Vienna, Austria (18 Nov 1974).

See STI/PUB—382; CONF-741120—.

A study of the distribution pattern of tritium in the soil/plant environment gives a valuable ecological information on the natural water balance. The results of such a study for the conditions obtaining in India are given in this paper. Field studies are carried out by injection of tritium into some soil/plant systems and following the transfer pathways. The method of extraction for tissue-free-water-tritium (TFWT) is based on the vacuum freeze-drying technique while the tissue-bound-tritium (TBT) is estimated by a modified version of the Shoniger method. The determination of residence time of tritium in aqueous and organic phase in a number of tropical trees has been carried out both for stem-injection as well as intake from the soil. From the results of this study the tree biomass and transpiration rates have been determined. The tritium profile over time, for an acute exposure in certain trees such as Morinda Tinetoria, Achras Sapota etc. shows significantly different patterns compared to the normal pattern shown by Mangifera Indica, Terminalia Catappa, Ficus Glomerata etc. The period of investigation in each case varied from 400 to 1000 h. In most of the cases, the TBT fractions were very low compared to TFWT fractions in the initial stages. The tritium behaviour in the tree reflects significant characteristics of the tritium behaviour in the soil system. The authors have found that the leaf sampling can be used as an indicator of total environmental tritium behaviour. (auth)

MICROORGANISMS

5828 (BNWL-SA—5531) **Microbial transformation of plutonium.** Robinson, A.V.; Garland, T.R.; Schneiderman, G.S.; Wildung, R.E.; Drucker, H. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 12p. (CONF-750985—3). Dep. NTIS $4.50.

From 15. Hanford life sciences symposium; Richland, Washington, USA (25 Sep 1975).

Analytical results indicate the reaction of Pu and fungal metabolites possibly occurs in the cell and the Pu compounds are then released into the exocellular media. Research has demonstrated that Pu-resistant microorganisms which have the ability to change the chemical form of a highly stable Pu complex can be isolated from soil. Continued research will be directed toward determination of the ability of Pu-resistant soil microbial isolates (maintained in stock cultures) to alter the solubility and mobility of the largely insoluble forms of Pu present in the environment. Since these studies involve a systematic investigation of the major classes of soil organisms, determination of their ability to alter Pu form in soil as well as in vitro and evaluation of the soil and environmental factors influencing their ability to transform Pu, the results should ultimately provide a realistic evaluation of the behavior of Pu in soil and the availability of Pu metabolites to plants. (CH)

CHEMICALS METABOLISM AND TOXICITY

MAN

5829 (LBL—3275) **VC-PVC crisis: a systematic approach to toxicological problems.** Kland, M.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 34p. (CONF-750673—3). Dep. NTIS $4.75.

From 30. northwest regional meeting American Chemical Society; Honolulu, Hawaii, USA (12 Jun 1975).

HEALTH AND SAFETY

5830 (LA—6125-PR) **Contamination limits for real and personal property. Progress report, January—June 1975.** Wenzel, W.J.; Healy, J.W. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-ENG-36. 4p. Dep. NTIS $4.00.

Data for the movement of various contaminants (^{89}Sr, ^{131}I, ^{32}P) from several different laboratory surface materials and textiles were examined and the fractional amount removed per unit time fitted to an arbitrary scale of level of action. Both the nature of the contaminant and the nature of the surface appear to affect the fractional removal although data are not available to define the dependence in any detail. (auth)

5831 (ORNL-TM—5134) **Laboratory services series: a safety program for service groups in a national research and development laboratory (1965—1974).** Winget, R.H. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 31p. Dep. NTIS $4.00.

The experiences of a ten-year period of developing a safety program for craft and labor groups supporting a major laboratory are summarized with tabulations of types of injuries or accidents, improvements noted over the decade, and educational and safety recognition efforts. (auth)

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

5832 Solar and galactic cosmic-ray activation of lunar samples. Eldridge, J.S. (Holifield National Lab., Oak Ridge, TN); O'Kelley, G.D.; Schonfeld, E. *Trans. Am. Nucl. Soc., Suppl.*; **21**: No. 3, 10(1975).

From International nuclear and atomic activation analysis conference and 19. annual meeting on analytical chemistry in nuclear technology; Gatlinburg, TN (14 Oct 1975).

STARS

5833 (LA-UR—75-735) **Observations of gamma-ray bursts.** Strong, I.B.; Klebesadel, R.W.; Evans, W.D. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 24p. (CONF-751202—1). Dep. NTIS $4.50.

From 7. Texas symposium on relativistic astrophysics; Dallas, Texas, USA (16 Dec 1974).

Observational data on gamma-ray bursts are reviewed. Information is grouped into temporal properties, energy fluxes and

spectral properties, and directions and distributions of the sources in space. (BJG)

5834 (LA-UR—75-1630) **Mass of AC Andromedae.** King, D.S.; Cox, A.N.; Hodson, S.W. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 8p. (CONF-750940—3). Dep. NTIS $4.00.

From 29. colloquium of the I.A.U. multiple periodic variable stars; Budapest, Hungary (1 Sep 1975).

Calculations indicate that AC Andromedae is population I rather than population II. A mass and radius for this star are calculated using a new set of opacities for the Kippenhahn la mixture. It is concluded that the mass is too high for an ordinary RR Lyrae star. (BJG)

5835 (LA-UR—75-1769) **Non-linear radiative transfer model of SW Andromadae.** Davis, C.G. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 12p. (CONF-750940—2). Dep. NTIS $4.00.

From 29. colloquium of the I.A.U. multiple periodic variable stars; Budapest, Hungary (1 Sep 1975).

The following parameters were used to develop a model of SW And.: Log L/L/sub sun/ = 1.6, Log T/sub eff/ = 3.835 and M = 0.6 M/sub sun/. Variable Eddington radiative transfer coupled hydrodynamic calculations, for gray and multi-group Cox-King (King-1A) mixture, were completed. In a comparison of the numerical results to observations, it appears that a multi-frequency radiative transfer calculation is needed since improvements in the B-V, log T/sub eff/ relation are obtained. It is proposed to use these atmospheres in a non-LTE line transfer code in order to make the more direct connection to observations. (auth)

5836 (UCRL—76947) **Neutrino flow and gravitational collapse.** Wilson, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Aug 1975. 36p. (CONF-750744—2). Dep. NTIS $5.00.

From Meeting of physics and astrophysics of neutron stars and black holes; Varenna, Italy (14 Jul 1975).

The discovery of neutral currents in neutrino interactions has made necessary the recalculation of the neutrino flow during stellar collapse. Neutral currents cause a coherent scattering cross section of complex nuclei proportional to the square of the atomic weight. This allows neutrinos to escape easily from the hot, dense center where only free baryons exist. The neutrinos then interact strongly in the outer region of high atomic weight and, under certain circumstances, produce a supernovae-like explosion in the outer reaches of the star, leaving a neutron star behind. For an explosion to occur, the scattering in the envelope of heavy nuclei must be greater than the scattering of the free baryons in the core. In particular, with Friedman's interpretation of Weinberg's theory, the cross section ratio is insufficient to produce an explosion. Other theories state that suppressing the free baryon cross section does lead to an explosion. (auth)

5837 (UCRL—76967) **Numerical study of rotating relativistic stars.** Wilson, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Aug 1975. 54p. (CONF-750744—1). Dep. NTIS $5.75.

From Meeting of physics and astrophysics of neutron stars and black holes; Varenna, Italy (14 Jul 1975).

The equations of structure for rotating stars in general relativity are presented and put in a form suitable for computer calculations. The results of equilibrium calculations for supermassive stars, neutron stars, and magnetically supported stars are reported, as are calculations of collapsing, rotating, and magnetized stars in the slowly changing gravitational field approximation. (auth)

5838 **Comments on the pulsation of double mode cepheids.** King, D.S. (Univ. of New Mexico, Albuquerque); Hansen, C.J.; Ross, R.R.; Stellingwerf, R.F.; Cox, J.P. *Mem. Soc. R. Sci. Liege;* **8**: 183-187(1975).

From International conference on astrophysics; Liege, Belgium (9 Jul 1974).

The pulsation properties of stellar envelope models for stars with periods appropriate to the double mode Cepheids are investigated. Three different chemical compositions are used with X = 0.70, Z = 0.02; X = 0.80, Z = 0.02 and X = 0.602, Z = 0.044. Certain conclusions can be reached with regard to the masses and radii of these stars on the basis of the calculations. Results for both linear and nonlinear computations are presented. (1 fig, 3 tables, 13 refs) (auth)

5839 **Hydrodynamic effects in the atmospheres of variable stars.** Davis, C.G. Jr. (Los Alamos Scientific Lab., NM). *Mem. Soc. R. Sci. Liege;* **8**: 197-207(1975).

From International conference on astrophysics; Liege, Belgium (9 Jul 1974).

Numerical models of variable stars are established, using a non-linear radiative transfer coupled hydrodynamics code. The variable Eddington method of radiative transfer is used. Comparisons are for models of W Virginis, β Doradus and eta Aquilae. From these models it appears that shocks are formed in the atmospheres of classical Cepheids as well as W Virginis stars. In classical Cepheids the bumps appearing in the light and velocity curves, for stars with periods from 7 to 10 days, appear as the result of a compression wave that reflects from the star's center in agreement with Christy. At the head of the outward going compression wave, shocks form in the atmosphere. Comparisons between the hydrodynamic motions in W Virginis and classical Cepheids are made. The strong shocks in W Virginis do not penetrate into the interior as do the compression waves formed in classical Cepheids. The shocks formed in W Virginis stars cause emission lines while in classical Cepheids, the shocks are weaker and their existence may possibly be evidenced in the recent Ultra-Violet (UV) data obtained via the O.A.O. satellite. (8 figs, 13 refs) (auth)

5840 **Non-linear radiation transport calculations to obtain mean colors and to verify the Wesselink method.** Cox, A.N.; Davis, C.G. (Los Alamos Scientific Lab., NM). *Mem. Soc. R. Sci. Liege;* **8**: 209-219(1975).

From International conference on astrophysics; Liege, Belgium (9 Jul 1974).

Four Cepheid models of mass 4, 4, 7, and 15 solar masses, one of the 4 solar mass models representing Beta Doradus, have been numerically integrated. The variable Eddington radiation approximation has been used for the surface layers to produce structures accurate enough for spectrum predictions. Spectra are predicted at about 100 phases over three pulsational cycles. B and V colors are computed at these phases. Mean colors are taken by four different methods that could be applied to colors of an observed Cepheid. The mean color that gives the closest effective temperature to that for the non-pulsating model uses the intensity mean of B and V separately. In no case is the mean color too blue and the mean effective temperature excessively hot. Thus with an assumed accurate luminosity, none of the mean effective temperatures obtained from the different mean colors give radii too small. The Cepheid mass discrepancy, with pulsation masses involving the method of color mean, remains, and pulsation masses are still only 70 percent of those needed in evolutionary calculations. A discussion of the Wesselink method for pulsating star radius determinations shows that only small positive systematic errors can occur in the derived mean radii. 8 figs. (auth)

5841 **Extremely carbon enhanced nova model.** Starrfield, S.G. (Arizon State Univ., Tucson); Sparks, W.M.; Truran, J.W. *Mem. Soc. R. Sci. Liege;* **8**: 425-429(1975).

From International conference on astrophysics; Liege, Belgium (9 Jul 1974).

A thermonuclear runaway in a white dwarf envelope that consists of equal numbers of protons and ^{12}C nuclei has been studied. It was found that these initial conditions cause a "super" nova outburst that does not result in any s- or r-process nucleosynthesis. This model reaches peak temperatures of 1.6 x 10^8 °K and peak burning rates exceeding 2 x 10^{23} erg/gm/sec. A shock forms and ejects 10^{29} grams moving with speeds up to 60,000 km/sec. The peak bolometric magnitude is -21.2m and this model will also produce a γ-ray burst. (GHT)

5842 **Age of HB21 and PSR 2021 + 51.** Jones, E.M. (Los Alamos Scientific Lab., NM). *Astron. Astrophys.;* **42**: No. 1, 147-150(Aug 1975).

The properties of the observed HI shell around supernova remnant HB 21 are used to derive an age between 0.26 and 0.79 million years. Ages in this range are inconsistent with properties of pulsar PSR 2021 + 51 which has been proposed as the neutron-star product of the HB 21 explosion. HB 21 may show marginal buoyant displacement. (auth)

5843 **On protostellar evolution.** Westbrook, C.K.; Tarter, C.B. (Department of Applied Science, University of California, Davis). *Astrophys. J.;* **200**: No. 1, 48-60(15 Aug 1975).

An investigation of the evolution of spherically symmetric protostars with initial masses in the range 0.1less than or equal toM/M/sub sun/less than or equal to50 has been carried out. In order to perform the calculations, a numerical technique has been developed in which rapid dynamical motions in one region of the star and quasi-static evolution in another region can be simultaneously computed. The general evolutionary features are similar to those found by other workers: an initial free-fall collapse is followed by the creation of a core in hydrostatic equilibrium, and the core's subsequent accretion of the surrounding envelope. However, our final hydrostatic-equilibrium configurations have radii large compared with those of the protostellar models of Larson (but in

reasonable agreement with those of conventional pre-main-sequence models). For low-mass protostars (Mless than or equal toM/sub sun/) the luminosity remains relatively small until late evolutionary times and the evolution is very sensitive to the treatment of convective energy transport. For large-mass protostars (Mgreater than or equal to3M/sub sun/) a convective phase never exists, and a fraction (increasing with mass) of the initial mass is ejected by the combined effects of heating and radiation pressure in the envelope.

5844 The soft x-ray spectra of Cassiopeia A and Tycho's supernova remnant. Hill, R.W.; Burginyon, G.A.; Seward, F.D. (Lawrence Livermore Laboratory, University of California, Livermore). *Astrophys. J.*; **200**: No. 1, 158-162(15 Aug 1975).

The x-ray spectra of Tycho's supernova remnant and Cas A have been measured with good statistics. Both spectra show evidence for silicon line emission. The thermal model of Tucker and Koren has been used to fit both spectra. To obtain a satisfactory fit to the data with this model, the silicon abundance must be increased about 10 times from the usual cosmic abundance values. Neither spectrum can be fitted with exponential or power-law models without the addition of line emission. Tycho's remnant shows very little soft X-ray absorption.

5845 Analysis of X-ray spectra reveals possibility of enhanced silicon in three supernova remnants. Burginyon, G.A.; Hill, R.W.; Seward, F.D. (Lawrence Livermore Laboratory, University of California, Livermore). *Astrophys. J.*; **200**: No. 1, 163-170(15 Aug 1975).

New calculations by Tucker and Koren for X-radiation from a thin hot plasma are applied to observed X-ray spectra of the Cygnus Loop, Vela X, and Puppis A. These calculations cannot satisfactorily describe the spectra of these three old supernova remnants when evaluated at one temperature and for commonly accepted cosmic abundances. However, all of the data are fitted when just two abundance values are changed: an increase in silicon by a factor of approximately 10, and a factor of 5 less iron. This modified set of abundances substituted into Tucker and Koren's model agrees with recent optical coronal line observations in the Cygnus Loop and explains spectra from recent observations of the supernova remnants Cas A and Tycho. It is remarkable that this thermal model with modified abundances fits the spectra of all these objects.

SOLAR PHENOMENA

5846 (LBL—3280) **Measurement of circumsolar radiation.** Grether, D.; Nelson, J.; Wahlig, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. 10p. (CONF-750852—1). Dep. NTIS $4.00.

From 19. annual technical symposium of the Society of Photo-Optical Instrumentation Engineers; San Diego, California, USA (18 Aug 1975).

An instrument system has been developed to measure the flux of energy from the sun and the circumsolar region (the small-angle region around the sun) as a function of angle, wavelength, and atmospheric conditions. The measurements are necessary to accurately predict the performance of solar thermal conversion systems using focusing collectors, and to determine whether pyrheliometer data are adequate for estimating this performance. The instrument system consists of a "scanning telescope", several conventional solar instruments, and a digital electronics control and recording system. The telescope makes a scan of + -3°, passing through the center of the sun. The angular resolution is approximately 1.5 minutes of arc from the center of the sun out to two solar radii, and 5 minutes from there out to 3°. The background caused by direct solar light scattering within the telescope itself has been reduced to less than 1 percent of the intensity of the circumsolar radiation. Spectral dependence of the radiation is determined using filters. A measurement program using this telescope will be carried out at various locations in the West and Southwest. Additional instruments are being constructed for deployment for the accumulation of data at potential sites for future solar power plants. (auth)

PLANETARY PHENOMENA

5847 (N—75-14577) **Radioactive halos and ion microprobe measurement of Pb isotope ratios. Final report.** Gentry, R.V. (Oak Ridge National Lab., Tenn. (USA)). 1974. 2p. (NASA-CR—140384). NTIS $3.25.

The Pb isotope ratios of both lunar and meteoritic troilite grains were to be measured by utilizing ion microprobe techniques. Such direct in situ measurement of Pb isotope ratios would eliminate contamination problems inherent in wet chemistry separation procedures, and conceivably determine whether lunar troilite grains were of meteoritic origin. For comparison purposes two samples of meteoritic troilite were selected (one from Canyon Diablo) for analysis along with two very small lunar troilite grains (approximately 50-100 microns). It was concluded that the ion microprobe as presently operating does not permit the in situ measurement of Pb isotope ratios in lunar or meteoritic troilite. On the basis of these experiments no conclusions could be drawn as to the origin of the lunar troilite grains. (auth)

5848 Some basaltic and andesitic gases. Anderson, A.T. (Univ. of Chicago). *Rev. Geophys. Space Phys.*; **13**: No. 1, 37-55(Feb 1975).

Data (mostly post-1963) on H_2O, B, CO_2, N_2, O_2, Ne, sulfur gases, Cl, ^{36}Ar, ^{40}Ar, Br, Kr, I, Xe, Hg, and Rn are reviewed. The compositions of volcanic gases are compatible with solubility and melt composition for H_2O, Cl, and possibly sulfur gases. For other gases there are either inadequate data or conflicting data (CO_2). Glassy basalts from the sea floor have substantial concentrations of both active and noble gases. It appears likely that magmatic gas of basalts at sea floor pressure is 60 percent SO_2, 20 percent H_2O, 10 percent H_2S, and 10 percent CO_2 at 1200°C. The concentrations of Cl and H_2O in basaltic and andesitic gases trapped in large crystals in pumices from continental margins are about 10 times those of deep sea basalts. Detailed relationships suggest that at least some andesitic magmas develop in vapor-saturated environments. The restored or potential concentrations of H_2O and Cl in andesitic magmas are estimated and used as a basis for estimating the rate of igneous outgassing in island arcs and continental margins. The inferred rates of outgassing are such that the present quantities of gaseous elements in seawater and sediment would be exhaled in 10^9 to 10^{10} years. The rates of outgassing of CO_2 from Kilauea volcano and of SO_2 from Pacaya exceed the rate which could be maintained by outgassing of erupted lava. These relations imply the existence of a larger source of these gases than that of the volcanic rocks. It seems probable that volcanic rocks are generally volumetrically small portions of subsurface reservoirs which may be vapor-saturated. Such a condition has major implications for crustal evolution, the origins of volcanic rocks, eruption mechanisms, and hydrothermal ore deposits. (auth)

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

5849 Report on the Brookhaven solar neutrino experiment. Davis, R. Jr.; Evans, J.C. Jr. (Brookhaven National Lab., Upton, NY). pp 91-110 of In Uskorenie chastits i yadernye reaktsii v kosmose. Kocharov, G.E.; Dergachev, V.A. (eds.). Leningrad; Ordena Lenina Fiziko-Tekhnicheskii Institut im. A. F. Ioffe (1974).

From Conference on particle acceleration and nuclear reactions in space; Leningrad, USSR (19 Aug 1974).

See CONF-740851—.

The Brookhaven Solar Neutrino experiment has been in operation since 1968. In this report the results of 10 experiments are given that extend over the period June 1971 to January 25, 1974. From these results it was concluded that the solar neutrino capture rate in ^{37}Cl is less than 1 SNU (SNU identical with 10^{-36} captures sec^{-1} atom $^{37}Cl^{-1}$). This result can be compared to the rate of 5.6 SNU predicted by standard solar model calculations. One experimental run for the period July 7 to November 5, 1972 gave an apparent rate of 6.2 +- 2.1 SNU and is higher than any other single experiment. A search was made for a possible neutrino pulse associated with the January 4, 1974 antineutrino pulse observed by the Pennsylvania-Texas water Cherenkov detectors. Neutrinos were not observed and a limit was set to the ratio of anti ν/ν greater than or equal to 4 if the January 4th event was produced by antineutrinos. A discussion is given of various tests performed to measure the recovery of ^{37}Ar in the detector system. New experiments to test further the argon recovery, and to measure the neutrino capture cross-section in ^{37}Cl are briefly described. (auth)

5850 Feasibility studies on a radiochemical lithium solar neutrino experiment. Rowley, J.K. (Brookhaven National Lab., Upton, NY). pp 111-124 of In Uskorenie chastits i yadernye reaktsii v kosmose. Kocharov, G.E.; Dergachev, V.A. (eds.). Leningrad; Ordena Lenina Fiziko-Tekhnicheskii Institut im. A. F. Ioffe (1974).

From Conference on particle acceleration and nuclear reactions in space; Leningrad, USSR (19 Aug 1974).

See CONF-740851—.

The feasibility of performing a radiochemical lithium solar neutrino experiment is presently under study at Brookhaven National Laboratory. The progress of these studies is reported here. Good progress has been made on the separation of the product,

^{7}Be, from the target, a 12 M LiCl solution in water. Experimental studies of several suitable efficient methods for achieving this separation are discussed. Possible methods for counting ^{7}Be are listed and the results of some preliminary investigations of some of these methods are reported. Moderate success in Geiger counting ^{7}Be in the gas phase has been achieved. Background processes which can also produce ^{7}Be are also listed and the estimated backgrounds due to these processes are reported. (auth)

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

5851 (CONF-7206111—(Absts.)) **Twenty-seventh symposium on molecular structure and spectroscopy, Columbus, Ohio, June 12—16, 1972. Abstracts.** (Ohio State Univ., Columbus (USA)). 1972. 212p. Ohio State Univ., Columbus.

From 27. symposium on molecular structure and spectroscopy; Columbus, Ohio, USA (12 Jun 1972).

Abstracts of 322 papers given at the symposium are presented along with a list of conference participants and the symposium program. (GHT)

5852 (CONF-7306123—(Absts.)) **Twenty-eighth symposium on molecular structure and spectroscopy, Columbus, Ohio, June 11—15, 1973. Abstracts.** (Ohio State Univ., Columbus (USA)). 1973. 231p. Ohio State Univ., Columbus.

From 28. symposium on molecular structure and spectroscopy; Columbus, Ohio, USA (11 Jun 1973).

Abstracts of 326 papers given at the symposium are presented along with a list of conference participants and the symposium program. (GMT)

BEAMS AND THEIR REACTIONS

5853 (JINR—P13-9146) **Cryogenic source of polarized atoms of hydrogen and deuterium.** Belushkina, A.A.; Vadeev, V.P.; Valevich, A.I.; Gai, G.I.; Donets, E.D.; Ershov, V.P.; Kotova, L.S.; Plis, Yu.A.; Pilipenko, Yu.K.; Smelyanskii, V.V. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 16p. (In Russian). Dep. NTIS (US Sales Only) $4.50.

An apparatus producing electron spin polarized atomic beams of deuterium and hydrogen is described. A cryopumping system, a superconducting sextupole magnet and liquid nitrogen cooled dissociator with a r.f. discharge are used. A possibility of developing of cryogenic polarized source is shown.Some advantages of such sources are discussed. (auth)

5854 (SAND—75-0455) **In situ investigation of substrate surface recontamination during glow discharge sputter cleaning.** Kominiak, G.J.; Uhl, J.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 22p. Dep. NTIS $4.00.

In the applications of thin film technology, the chemical nature of the substrate surface is known to affect the film/substrate interactions. Undesirable contaminants in the interfacial region may affect film nucleation, adhesion and electrical or optical properties. Often, glow discharge sputter cleaning is used as a surface preparation technique prior to thin film deposition. Since this method of sputter cleaning is performed in a gaseous environment where the mean free path of the sputtered atoms is short, there is a possibility of surface recontamination by material sputtered from the substrate and from surrounding fixturing. In this investigation, we have used soft x-ray appearance potential spectroscopy to monitor, in situ, the substrate surface composition after sputter cleaning with both D. C. and R. F. discharges. Data are presented which show that common contaminants such as carbon and oxide layers may be adequately removed by either D. C. or R. F. glow discharge sputter cleaning. D. C. sputter cleaning was found to recontaminate the surface with materials sputtered from the substrate support and from nearby ground shielding. R. F. sputter cleaning, when performed at high bias levels (approximately 2kV) and at low gas pressures (greater than 10μ), is capable of producing a surface free of added impurities. (auth)

5855 (UCID—16890) **Motion of charged particles in periodically varying magnetic fields.** Rowlands, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1975. Contract W-7405-Eng-48. 17p. Dep. NTIS $4.00.

A simple theory is developed to study the containment of charged particles in a periodic array of current carrying conductors. (auth)

5856 **Excited-state formation as H^+ and He^+ ions scatter from metal surfaces.** Baird, W.E.; Zivitz, M.; Thomas, E.W. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332). *Phys. Rev., A;* 12: No. 3, 876-884(Sep 1975).

Impact of 10-to30KeV H^+ or He^+ ions on polycrystalline metal surfaces causes some projectiles to be backscattered in a neutral excited state. These projectiles subsequently radiatively decay, emitting Doppler-broadened spectral lines. By analysis of the spectral shape of these lines, we are able to determine the probability of radiationless deexcitation of the excited backscattered atoms. Quantitative measurements of spectral intensity indicate that less than 1% of all projectiles are backscattered in an excited state. The relative variation of total spectral line intensity with angle of projectile incidence and with projectile primary energy has been successfully predicted using a model which assumes that the probability for excited-state formation is independent of the scattered projectile's energy and direction. The variation in total spectral line intensity with target atomic number is predicted, and the sputtering and excitation of Al under He^+ impact is briefly examined.

5857 **Auger electron spectroscopy in sputtering measurements: Application to low-energy Ar^+ sputtering of Ag and Nb.** Smith, J.N. Jr.; Meyer, C.H. Jr.; Layton, J.K. (General Atomic Company, San Diego, California 92138). *J. Appl. Phys.;* 46: No. 10, 4291-4293(Oct 1975).

The sputtering of Ag and Nb by Ar^+ in the energy range from 0.5 to 1.5 keV has been measured. The agreement with extant data, where available, is good. The experimental technique is a new adaptation of certain earlier methods and employs Auger electron spectroscopy of a continuously sputtered area of a thin-film composite structure, produced by vapor deposition. This new method should permit very low sputter yields (Sapproximately-less-than10^{-3}) to be measured in subsequent experiments.

5858 **Ion source of high brightness using liquid metal.** Krohn, V.E.; Ringo, G.R. (Argonne National Laboratory, Argonne, Illinois 60439). *Appl. Phys. Lett.;* 27: No. 9, 479-481(1 Nov 1975).

The beam from an EHD ion source using liquid gallium has been shown to have a brigtness of 0.9times10^5 A cm^{-2} sr^{-1} at 21 kV and an energy spread of 12 eV at 10-μA total current. The effective source diameter was 0.2 μm as imaged by a 2-cm-long Einzel lens with a 0.12-mm aperture. Cesium was significantly poorer and mercury much poorer than gallium.

5859 **Backscattering of keV molecular hydrogen ions from Au surfaces.** Eckstein, W.; Verbeek, H.; Datz, S. (Max Planck Institut fur Plasmaphysik, EURATOM Association, D-8046 Garching, Germany). *Appl. Phys. Lett.;* 27: No. 10, 527-528(15 Nov 1975).

Appreciable quantities of molecular hydrogen ions have been observed in backscattering of 5-keV D_3^+ from Au. At a scattering angle of 10degree the D_2^+/D_1^+ ratio was 5times10^{-2} and $D_3^+/D_1^+\Phi$ 2 times10^{-4}. The ratios decrease with increasing scattering angle, but D_3^+ is observable at angles up to 50degree.

ATOMIC AND MOLECULAR PROPERTIES

5860 (LBL—4258) **Radiative decay of the 2^3P states of heliumlike argon.** Davis, W.A.; Marrus, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 15 Sep 1975. Contract W-7405-Eng-48. 3p. (CONF-750975—10). Dep. NTIS $4.50.

From 4. international conference on beam-foil spectroscopy; Gatlinburg, Tennessee, USA (15 Sep 1975).

Preliminary results are presented on a measurement of the lifetimes and wavelengths of the allowed E1 decays from 2^3P states of helium-like ArXVII. A vacuum ultraviolet monochromator was used to view the decay radiation of the transitions 2^3P_2 - 2^3S_1 and 2^3P_0 and 2^3S_1. The results are shown in a table comparing observed and predicted lifetimes. (1 table) (GHT)

5861 (UCLA—34P88-36) **Intra- and inter-molecular energy transfer studies. Progress report, 1 June 1974—31 May 1975.** Nicol, M.F. (California Univ., Los Angeles (USA). Dept. of Chemistry). 15 Jul 1975. Contract E(04-3)-34. 29p. Dep. NTIS $4.50.

The analysis of pressure-induced effects on the intersystem crossing in anthracene; determination of the influence of hydrogen-bonding on the intersystem crossing rate and phosphorescence of azines; experimental studies of the kinetics of high-pressure structural transitions in Teflon; testing of liquid helium temperature high-pressure optical cells; excimer production in compound crystalline aromatic hydrocarbons; and studies of the structure and chemistry of dianthracene at high pressures are described. (6 figs.) (GHT)

5862 **Auger spectra of the noble gases. Krypton.** McGuire, E.J. (Sandia Labs., Albuquerque, NM). *Phys. Rev., A;* 11: No. 1, 17-25(Jan 1975).

The Auger single 3d vacancy and satellite spectrum for Kr is calculated. It is shown for the single-vacancy $M_{4,5}$— N N spectra that the calculations are in good agreement with experiment only if

certain levels in Kr III are reassigned. The level at 171,997 cm^{-1} attributed in Moore's tables to $(4p)^3\ ^2D(4d)\ ^1P_1$ is assigned to the missing $^2P_1$ term, and the $^1P_1$ is located at 196,500 cm^{-1}. These reassignments are consistent with expected configuration-interaction effects. As a result the low-energy doublet in the Kr $M_{4,5}$- N N spectrum is identified as the $M_{4,5}$-N_1N_1 transition, in agreement with recent energy calculations. Calculations were made to reproduce the observed satellite spectra $(3d)(4p)$ yields $(4p)^3$ and $(3d)(4p)$ yields $(4s)(4p)^2$, with both a statistical distribution of shakeoff and Auger decay of 3p vacancies, as population mechanisms for the $(3d)(4p)$ configuration. It was found that the $(3d)(4p)$-$(4p)^3$ calculations with an initial $(3d)(4p)$ population distribution from Auger decay of 3p vacancies were in excellent agreement with experiment, while the statistically distributed shakeoff hypothesis leads to relatively poor agreement. For the $(3d)(4p)$ yields $(4s)(4p)^2$ neither calculation is in agreement with experiment, because of the neglect of configuration interaction. The summed calculated intensity appears to agree with the summed measured intensity for an initial $(3d)(4p)$ population produced by Auger decay of 3p vacancies. Statistically distributed shakeoff leads to a summed intensity far in excess of the summed measured intensity. We conclude that statistically distributed shakeoff must have a probability significantly less than 5 percent, in contrast to recent calculations indicating 10 percent shakeoff. 9 figs., 20 refs. (auth)

5863 Lifetime of 2^3S_1 state in heliumlike sulfur and chlorine. Bednar, J.A.; Cocke, C.L.; Curnutte, B.; Randall, R. (Kansas State Univ., Manhattan). *Phys. Rev., A;* 11: No. 2, 460-464(Feb 1975).

Beam-foil measurements of the lifetimes of the $2\ ^3S_1$ state in heliumlike sulphur and chlorine are reported. A Doppler-tuned x-ray spectrometer was used to detect the x rays emitted from the $1\ ^1S_0$ - $2\ ^3S_1$ transition. Time-of-flight techniques were used to trace the decay profile of the emitted x rays for 38-55-MeV sulphur and chlorine beams over flight paths of 56-861 cm. For foil-to-detector flight times greater than one half the theoretical lifetimes of 698 nsec (sulphur) and 374 nsec (chlorine), the respective experimental lifetimes of 706 +- 86 and 354 +- 24 nsec are in agreement with theory. For shorter flight times, the experimental decay profiles are not single exponentials. This experimental effect is the source of the previously reported discrepancy between experimental and theoretical lifetimes of the $2\ ^3S_1$ state in heliumlike chlorine. (auth)

5864 Lifetimes of metastable autoionizing $(1s2s2p)^4$P/sub 5/2/ states of lithiumlike Al^{10+} and Si^{11+} ions: comparisons with theory over the isoelectronic sequence Z = 8—18. Haselton, H.H.; Thoe, R.S.; Mowat, J.R.; Griffin, P.M.; Pegg, D.J.; Sellin, I.A. (Univ. of Tennessee, Knoxville). *Phys. Rev., A;* 11: No. 2, 468-472(Feb 1975).

Lifetimes of the lowest, most metastable, autoionizing quartet state $(1s2s2p)\ ^4$P/sub 5/2/ of the lithiumlike ions Al^{10+} and Si^{11+} were measured by the electron spectrometric, time-of-flight technique and are found to be 2.9 +- 0.2 and 2.1 +- 0.1 ns respectively. These results can be compared to very recent Dirac-Hartree-Fock lifetime calculations of Cheng, Lin, and Johnson which give 2.58 and 1.84 ns, respectively. Comparison of the experimental results for the sequence Z = 8, 9, 13, 14, 16, 17, and 18 with the new theoretical calculations show that the measured lifetimes tend to be systematically larger than those predicted from theory, after proper allowance for an M2 radiation-decay channel is made. Possible reasons for these systematic differences are mentioned. (auth)

5865 Difference in dipole moment for molecules in different zero-field levels of the lowest triplet state by Stark-PMDR spectroscopy. Sheng, S.J.; El-Sayed, M.A.; Leung, M. (Univ. of California, Los Angeles). *J. Chem. Phys.;* 62: No. 5, 1988-1990(1 Mar 1975).

Spin—orbit coupling between triplet states could induce variation in the permanent dipole moment of molecules in the different zero-field (zf) levels of the same electronic triplet state. Such a difference can be detected by the first-order Stark effect on the zf phosphorescence microwave double resonance signals. The first observation of this effect is reported, from which it is determined that molecules in the different zf levels of the lowest triplet state of duraldehyde can differ in their dipole moment by approximately 10^{-3} D. 1 figure, 1 table (RWR)

5866 Lifetime of the metastable $^3P_2$ and $^3P_0$ states of rare-gas atoms. Small-Warren, N.E.; Chow Chiu, L.Y. (Howard Univ., Washington, DC). *Phys. Rev., A;* 11: No. 6, 1777-1783(Jun 1975).

The lifetimes of the $^3P_2$ states of Ne, Ar, Kr, and Xe are calculated by considering the spin-dependent magnetic-quadrupole (SM2) radiative transition to the $^1S_0$ state as the decay mechanism. By expressing the SM2 operator as a contraction of the spin magnetic dipole and the electric dipole, the lifetime of the $^3P_2$ state can be expressed very simply in terms of that of the $^1P_1$ state. With the known lifetimes of the $^1P_1$ state, the calculated lifetimes of the $^3P_2$ states are 24.4, 55.9, 85.1, and 145.5 sec, respectively, for Ne, Ar, Kr, and Xe. The lifetime of the $^3P_0$ state is calculated by considering both the magnetic-dipole (M1) transition to $^3P_1$ and the electric-quadrupole (E2) transition to $^3P_2$ as the decay mechanism. The calculated lifetimes are 430, 44.9, 0.488, and 0.078 sec, respectively, for Ne, Ar, Kr, and Xe. These calculated lifetimes are above the lower limits of the experimental lifetimes measured by Van Dyck, Johnson, and Shugart. (auth)

5867 Perturbation theory for the Stark effect in the hyperfine structure of alkali-metal atoms. Lee, T. (State Univ. of New York, Albany); Das, T.P.; Sternheim, R.M. (State Univ. of New York, Albany). *Phys. Rev., A;* 11: No. 6, 1784-1786(Jun 1975).

The quadratic Stark effect on the hyperfine structure in the ground states of the alkali-metal atoms, lithium through cesium was studied. The leading perturbation terms were evaluated using two sets of first-order wave functions, corresponding respectively to perturbations of the atomic wave functions by the electric field and by the nuclear moment. The perturbed wave-functions were obtained by solving the appropriate differential equations in first-order perturbation theory. The theoretical results agree very well with the recent experimental data for the entire series of alkali-metal atoms. A discussion of the relation of these theoretical results to earlier ones in some of the alkali-metal atoms is also presented. (auth)

5868 Heliumlike ^{19}F: 2^3P_2 and 2^3P_0 lifetimes. Mowat, J.R.; Griffin, P.M.; Haselton, H.H.; Laubert, R.; Pegg, D.J.; Peterson, R.S.; Sellin, I.A.; Thoe, R.S. (Univ. of Tennessee, Knoxville). *Phys. Rev., A;* 11: No. 6, 2198-2201(Jun 1975).

We have measured the lifetimes of $(1s2p)\ ^3P_{0,2}$ in heliumlike fluorine in a search for the nuclear-spin-induced quenching of the $^3P_0$ state. Both fine-structure decays ($2\ ^3S_1$ - $2\ ^3P_{0,2}$) were observed following foil excitation of a 15-MeV F beam. Within experimental error (+- 10 percent) the two states have the same lifetime (10 nsec) in agreement with theoretical 2p-2s E1 decay rates. (auth)

5869 High resolution study of photoionization processes in O_2. Dehmer, P.M.; Chupka, W.A. (Argonne National Lab., IL). *J. Chem. Phys.;* 62: No. 11, 4525-4534(1 Jun 1975).

Relative photoionization efficiency curves were determined for the production of O_2^+, O^+ and O^- from molecular oxygen in the wavelength region for the helium continuum. The photoionization efficiency curve for O_2^+, determined at a wavelength resolution (FWHM) of 0.07 A throughout most of the region from 1030-580 A, shows rotationless autoionization structure which is broadened due to the processes of predissociation and/or autoionization. The photoionization efficiency curves for fragment ions from ion pair formation and from dissociative ionization were determined at wavelength resolutions of 0.07 and 0.15 A, respectively. The data show considerable autoionization structure and provide information about the mechanisms for these dissociation processes. The ion pair photoionization efficiency curve shows steplike structure at threshold resulting from direct ionization from individual rotational levels of the ground state of O_2. A value of the electron affinity of atomic oxygen of 1.462 +- 0.003 eV was determined from the wavelength corresponding to ionization from the $O_2(^3\Sigma$/sub g/$^-$, $v = 0$, $J = 1$) ground state. (auth)

5870 Semiclassical transition state theory for nonseparable systems: Application to the collinear $H+H_2$ reaction. Chapman, S.; Garrett, B.C.; Miller, W.H. (Department of Chemistry and Inorganic Materials Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.;* 63: No. 6, 2710-2716(15 Sep 1975).

Two different kinds of semiclassical approximations are used to evaluate a previously obtained quantum mechanical transition state theory rate expression. No assumptions, however, such as separability of the Hamiltonian, vibrationally adiabatic motion along a reaction coordinate, etc., are incorporated. Application is made to the collinear $H+H_2$ reaction, and agreement with accurate quantum scattering calculations is found to be reasonably good. The results indicate that transition state theory: provided no assumptions of separability are included: is probably as accurate quantum mechanically as it has been found to be classically for describing the threshold of chemical reactions with an activation barrier.

5871 Theory of electron—electron interaction effects on antishielding factors of negative ions. Beri, A.C. (State Univ. of New York, Albany); Ray, S.N.; Das, T.P.; Sternheimer, R.M. *Phys. Rev., A;* 12: No. 4, 1168-1175(Oct 1975).

The influence of electron-electron interaction effects on nuclear quadrupole antishielding factors γ/sub infinity/ is studied

for the negative halide ions F^-, Cl^-, and Br^-. With a procedure developed earlier which utilizes the nuclear-quadrupole-moment-perturbed and external-point-charge-perturbed wave functions for the ions, obtained by the differential equation procedure for the zero-order antishielding factor (γ/sub infinity/)$_0$, the consistency contributions (γ/sub infinity/)$_1$ have been computed to be +2.28, −1.50, and −7.16 in F^-, Cl^-, and Br^-, respectively. The resulting values of γ/sub infinity/ correct to first order in electron-electron interaction are then −19.29, −56.58, and −140.83. The appearance of negative signs for (γ/sub infinity/)$_1$ in Cl^- and Br^- is seen to be due to large negative interactions between p electrons belonging to different shells. This intershell effect is not present in F^- ($1s^22s^22p^6$). The contributions to (γ/sub infinity/)$_1$ for all three ions are analyzed in detail, and a comparison is made of (γ/sub infinity/)$_1$ for F^- and the isoelectronic positive ion Na^+. An explanation is proposed for the comparable values of the ratio (γ/sub infinity/)$_1$/(γ/sub infinity/)$_0$ found for these two ions, even though the F^- ion is substantially more deformable with a larger value of (γ/sub infinity/)$_0$. From the results of the present investigations, as well as earlier ones in related positive ions, it is felt that the consistency contribution (γ/sub infinity/)$_1$ should, in general, be less than 15 percent of (γ/sub infinity/)$_0$ for most ions. (auth)

5872 Spectrum of six-times ionized rhenium (Re VII). Kaufman, V.; Sugar, J. (National Bureau of Standards, Washington, DC). *Phys. Rev., A;* 12: No. 4, 1402-1403(Oct 1975).

Six terms of the $4f^{14}5s^25p^6(^1S_0)nl$ doublet system of ReVII have been found, including nl = 5d, 5f, 6s, 6p, 6d, and 7s. Thirteen spectral lines were classified in this system of levels. The partially resolved hfs of the 6s-6p multipiet was used to derive a value for the hyperfine splitting of the 6s level in agreement with a predicted value. The ionization energy of REVII derived from the ns series is 82.74 +- 0.06 eV. (auth)

5873 K-shell x-ray production cross sections of selected elements Ti to Sb for 1.0- to 5.0-MeV/amu ^{7}Li ions. McDaniel, F.D.; Gray, T.J.; Gardner, R.K.; Light, G.M.; Duggan, J.L.; Var Rinsvelt, H.A.; Lear, R.D.; Pepper, G.H.; Nelson, J.W.; Zander, A.R. (Department of Physics, North Texas State University, Denton, Texas 76203). *Phys. Rev., A;* 12: No. 4, 1271-1280(Oct 1975).

K-shell x-ray production cross sections for thin targets of selected elements Ti to Sb have been measured for ^{7}Li ions in energy steps of 0.2 MeV/amu in the range from 1.0 to 5.0 MeV/amu. Comparisons of the cross-section data for the ligher elements (Z_2less than or equal to28) to the plane-wave Born approximation (PWBA) and the PWBA corrected for binding energy and Coulomb deflection show that the data are best represented at the lower energies by the corrected PWBA and approach the PWBA at the higher energies. When approximate relativistic corrections are made to the theories for the heavier elements studied, the same general trend is observed. Calculation of the ratio $R=\sigma(Z_1)/Z_1^2\sigma(Z_1=1)$ supports the inclusion of binding-energy and Coulomb deflection corrections to the PWBA at the lower ion energies. The corrections to the PWBA, while improving the fit to the data, underestimate the cross sections by 10—100% in all cases. The $K\beta/K\alpha$ ratios are found to be in good agreement with theoretical estimates assuming single-hole ionization.

5874 Long-lived K/sub a/ = O, $^2B_1$ states of NO_2: a direct measurement using a tunable dye laser. Haas, Y. (Univ. of California, Berkeley); Houston, P.L.; Clark, J.H.; Moore, C.B.; Rosen, H.; Robrish, P. *J. Chem. Phys.;* 63: No. 10, 4195-4197(15 Nov 1975).

Narrow-band (1 GHz) excitation coupled with selection of specific emission bands has been used to measure the lifetimes of some K/sub a/ = 0, $^2B_1$ states of NO_2. In contrast with previous experiments and expectations of short lifetimes based on analysis of possible perturbations in the electronic manifold, these states exhibit long collisionless lifetimes of 33 +- 4 μsec. Their quenching cross sections are found to be larger than gas kinetic, and much larger than that for the unresolved fluorescence. (auth)

5875 Potential energy and force constants of a potassium chloride molecule from extended Hueckel calculations. Hathaway, K.B.; Krumhansl, J.A. (Cornell Univ., Ithaca, NY). *J. Chem. Phys.;* 63: No. 10, 4313-4316(15 Nov 1975).

The potential energy and vibrational force constants of a potassium chloride molecule are calculated by the extended Hueckel molecular orbital method using analytic approximations to the Hartree-Fock atomic orbitals in the computation of overlaps. The addition of a simple Coulomb attractive energy to the repulsive extended Hueckel energy yields total potential energies in reasonable agreement with the experimental energy curve. (auth)

5876 Vibronic spectra of the ozonide ion in the matrix-isolated $M^+O_3^-$ species. Andrews, L. (Univ. of California, Berkeley). *J. Chem. Phys.;* 63: No. 10, 4465-4469(15 Nov 1975).

Matrix reactions of alkali metal atoms and ozone molecules at high dilution in inert gases produced a clear yellow film during condensation at 10-22 K on a sapphire plate which yielded vibronic spectra of the $M^+O_3^-$ species. Best resolution of up to 14 vibronic bands spaced 800-900 cm^{-1} apart was obtained for the lithium and sodium compounds. These bands formed a strong progression in ν_1' and the first six bands exhibited the presence of a weaker progression in ν_2'. The band origin was located at 17730 cm^{-1} for $Li^+{}^{16}O_3^-$ and $Li^+{}^{18}O_3^-$ in solid krypton. Harmonic and anharmonic vibrational constants were determined graphically for the excited electronic state. (auth)

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

5877 Vacuum polarization in strong, realistic electric fields. Rinker, G.A. Jr.; Wilets, L. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). *Phys. Rev., A;* 12: No. 3, 748-762(Sep 1975).

Electron-positron vacuum polarization potentials, accurate to all orders n in ($Z\alpha$)/subn/, are calculated using realistic nuclear charge distributions for selected nuclei with 26 less than or equal to Z less than or equal to 114, and for the quasimolecule U-U. We give further details of the numerical methods used in calculations previously reported, and of the improvements which have led to the present increased accuracy. The vacuum polarization potentials are employed to determine muonic energy-level shifts order ($Z\alpha$)/subn/ /sup greater-than-or-equal//sup ts//sup $1/\alpha$ for most relevant states with l less than or equal to 6. For the shifts of order ($Z\alpha$)/subn/ /sup greater-than-or-equal//sup ts//sup $3/\alpha$, interpolation procedures for all values of Z < 137 and for other exotic particles are noted. Although the effect of finite nuclear size is small for high-lying states ~ 10% reduction of the ($Z\alpha$)/subn/ /sup greater-than-or-equal//sup ts//sup $3/\alpha$ terms in heavy atoms, it yields a reduction by a factor approximately-greater-than 2 for low-lying states. In the case of the quasimolecule U-U, we find that the total vacuum polarization is a minor correction to the dominant Coulomb interaction, with the first-order (Uehling) contribution remaining larger than the higher-order terms. We also present further details of a previous calculation of order $(Z\alpha)^2\alpha^2$ in muonic lead.

5878 Photon propagation in nuclear matter and the correction to the theoretical nuclear charge density. Tanabe, K. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). *Phys. Rev., C;* 12: No. 4, 1346-1353(Oct 1975).

The polarization function is derived for a virtual photon propagating in uncorrelated nuclear matter. The modification of the photon propagator and the induced charge distribution in the presence of the external field source are expressed in terms of a finite effective photon mass which is dependent on the Fermi momentum. The application is made to a finite nucleus by subtracting the local field due to the surrounding infinite matter distribution. It is found that the correction to the potential due to the scattering of exchanged virtual photons by the nucleus results in a short-range repulsive force on the orbiting muon in muonic atoms. The estimated energy shifts are -560 eV for the $2p_1/_2$yields$1s_1/_2$ transition, and -291 eV for the $3d_5/_2$yields$2p_3/_2$ transition in ^{208}Pb; and -58 eV and -2.5 eV, respectively, in ^{90}Zr. The effects are negligible for higher orbits.

COLLISION PHENOMENA

5879 (LBL—3798) **Vibrational inelasticity in H_2 collisions with He and Li^+.** Raczkowski, A.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-Eng-48. 127p. Dep. NTIS $7.00.

Thesis.

The partially averaged version of classical S-matrix theory was applied to three-dimensional collisions of H_2 with He and Li^+. For H_2-Li^+, cross-sections for the de-excitation of H_2 from $(n_i,j_i) = (1,0)$ to the ground vibrational manifold were computed at a total energy of 1.2 eV and compared to previously done coupled channel calculations of Schaefer and Lester. The agreement is very good. For H_2-He, the Kutzelnigg-Tsapline interaction potential was extended to small atom-diatom separations, the ab initio points were then fit to an analytic form, and cross sections for the de-excitation of H_2 from the states (n_i,j_i), $n_i = 1$, $j_i = 0,2,4$ to the ground vibrational manifold were computed at total energies of .9, 1.1, 1.3 and 1.5 eV. For comparison, coupled channel calculations were also performed on the system at the same energies. The agreement was poorer than in the H_2-Li^+ case, for identifiable reasons. The cross sections were used to compute rate constants and relaxation times for the H_2-He system. Comparison of these results with the results of experiment and of other calculations shows good agreement, certainly within the expected errors. (7 figs., 30 refs., 3 tables) (auth)

5880 (SAND—75-8289) **ETANM: a code for analytical photo-Compton current calculations.** Huddleston, R.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 33p. Dep. NTIS $5.00.

A new code, ETANM, has been developed to use analytical transport methods to predict the complete angular distribution of vacuum photoemitted electrons. Previous codes were capable of predicting the polar, but not the azimuthal dependence of the electrons. A spatially uniform monoenergetic electron source with an arbitrary initial angular distribution is considered. The code will become part of the QUICKE code which calculates the electron sources generated in a given photon environment. A microfiche of the subroutines of the code is included with the report. (auth)

5881 Rotational excitation of HF in slow collisions with He. Collins, L.A.; Lane, N.F. (Physics Department, Rice University, Houston, Texas 77001). *Phys. Rev., A;* **12**: No. 3, 811-815(Sep 1975).

Low-energy rotational-excitation cross sections have been calculated from model-potential surfaces constructed to represent the interaction of atomic helium with hydrogen fluoride (HF). Quantum-mechanical solutions of the coupled equations were obtained including as many rotational states (open and closed) as needed for convergence. The behavior of the cross sections as a function of energy and the sensitivity to various model-potential surfaces are discussed.

5882 Electron transfer in keV-energy $^4He^{++}$ collisions. III. Experimental tests of the close-coupling calculations for $^4He^{++}$-H(1s) collisions. Bayfield, J.E.; Khayrallah, G.A. (J. W. Gibbs Laboratory, Physics Department, Yale University, New Haven, Connecticut 06520). *Phys. Rev., A;* **12**: No. 3, 869-875(Sep 1975).

Two experimental tests of the $^4He^{++}$-H(1s) close-coupling collision calculations were performed with a highy mass-resolved $^4He^{++}$ incident ion beam and an atomic hydrogen scattering target. The total single-electron-transfer cross section σ_{21}(H) was measured for $^4He^{++}$ energies between 7 and 144 keV, with the results in better agreement with molecular-state calculations than with theory employing atomic states. Above 25 keV this cross section is 50% above values obtained Shah and Gilbody for incident $^3He^{++}$ with the same collision velocity. Also measured was the cross section σ_{21}* (H) for single-electron transfer into the 2s state of He^+ using an ion-photon time-coincidence technique over the $^4He^{++}$ energy range 7 to 70 keV. These data differ with the corresponding $^3He^{++}$-H(1s) data of Shah and Gilbody at the higher energies. For σ_{21}* (H), the observed energy dependence as well as the magnitude at the lower energies are in marked disagreement with all close-coupling results.

5883 Radiative capture and recombination in electron-atom collisions. Hahn, Y. (Department of Physics, University of Connecticut, Storrs, Connecticut 06268). *Phys. Rev., A;* **12**: No. 3, 895-907(Sep 1975).

A comprehensive theory of electron scattering from atoms and ions at high energies is formulated, incorporating the coupling of the scattering system to the radiation field. In particular, the photocapture process is discussed in detail, which can proceed either by a direct radiative capture or by dielectronic recombination following a radiationless capture into excited states. The latter process involves a collisional excitation of the inner-shell electrons of the target, followed by radiative decay of that excited state. The required sum over excitation probabilities to all the allowed bound states is estimated using the semiclassical projection operators and the single-particle model for the target system. A preliminary estimate of the cross sections for these modes of capture is obtained for the case of a hot-electron plasma interacting with highly ionized impurity ions.

5884 Negative ion properties of p-benzoquinone: Electron affinity and compound states. Cooper, C.D.; Naff, W.T.; Compton, R.N. (Department of Physics, University of Georgia, Athens, Georgia 30602). *J. Chem. Phys.;* **63**: No. 6, 2752-2757(15 Sep 1975).

Bound and excited negative ion states of para-benzoquinone (PBQ) are studied from experiments involving collisions of electrons and cesium beams with PBQ. The electron affinity of PBQ was measured to be 1.89+0.2/sub -//sub 0/./sub 3/ eV using the cesium collisional ionization technique. $PBQ^-(C_6H_4O^-_2)$ was the dominant negative ion observed following collisions of cesium beams with PBQ. Direct electron attachment to PBQ produced the fragment ions $C_3H_4O^-$, $C_3H_2O^-$, $C_4O_2H^-_2$, C_2HO^-, and C_2H^- as well as the parent $C_6H_4O^-_2$ ion. Our observations showed that the cross section for producing the metastable parent negative ion, $C_6H_4O^-_2$, peaks at 1.40plus-or-minus0.1 eV which is in disagreement with a previous value of 2.1 eV. Attachment of thermal electrons to PBQ at low pressure ($<10^{-4}$ mm Hg) was not observed. Compound negative ion states were observed to peak at 0.70, 1.35, and 1.90 eV using the SF_6 scavenger technique. The energies of these compound states agree qualitatively with the energies if the manifold of unfilled π^* orbitals. The long-lived state at 1.4 eV is attributed to either (a) direct attachment of the incident electron into the $^2b_1$/subu orbital followed by internal conversion to the ground $^2B_3$/subg/ of PBQ^- or (b) simultaneous excitation of a core electron and attachment of the incident electron into an excited orbital (i.e., core excited Feshbach resonance) as previously suggested. Evidence is presented for the former explanation.

5885 Ion-beam implosion of fusion targets. Clauser, M.J. (Plasma Theory Division, Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev. Lett.;* **35**: No. 13, 848-851(29 Sep 1975).

The performance of ion-beam: irradiated fusion targets consisting of a high-density spherical shell containing DT gas has been calculated. Breakeven with 10-MeV protons irradiating 1: 2-mm-diam targets can be produced with a beam current around 10 MA. Results for various target sizes and other beam particles and voltages are also discussed.

5886 Sharing of K vacancies in heavy-ion—atom collisions. Jones, K.W.; Jundt, F.C.; Guillaume, G.; Fintz, P. (Laboratoire de Physique Nucleaire et d'Instrumentation Nucleaire, Centre de Recherches Nucleaires et Universite Louis Pasteur, Strasbourg, France). *Phys. Rev., A;* **12**: No. 4, 1232-1236(Oct 1975).

The production of K vacancies has been measured for target and projectile atoms in Ne-Al and Ar-Al, -Cl, -Ti, -Cr, -Fe, -Ni collisions at energies ranging from 0.75 to 16 MeV. The results have been examined in terms of the K-vacancy-sharing theory of Meyerhof. Agreement between theory and experiment is generally good, although there is some indication of deviations at low energies.

5887 L-shell x-ray production cross sections for ^{16}O ions on Ce, Pr, Sm, Eu, Dy, and Ho: 0.50 to 2.25 MeV/amu. Pepper, G.H.; Lear, R.D.; Gray, T.J.; Chaturvedi, R.P.; Moore, C.F. (Department of Physics, North Texas State University, Denton, Texas 76203). *Phys. Rev., A;* **12**: No. 4, 1237-1245(Oct 1975).

L-shell and individual x-ray production cross sections for 8—36-MeV oxygen ions on thin solid targets of Ce, Pr, Sm, Eu, Dy, and Ho are measured and compared with predictions of theories of direct Coulomb ionization. In comparing theory and experiment, we use, with reasonable justification, fluorescence yields, Coster-Kronig yields, and radiative widths obtained from single-hole initial configurations. The theoretical treatment which provides the best overall fit to the data is the plane-wave Born approximation with corrections for Coulomb deflection of the projectile and increased binding of the target electrons. The effects of multiple ionization are examined through measurement of x-ray energy shifts as measured with Si(Li) detectors and by vacuum crystal-spectrometer measurements of L x-ray spectra produced by 3-MeV proton and 25-MeV oxygen-ion bombardment of a thick La target.

5888 Theoretical investigation of the nonadiabatic interactions and the translational factors in proton-hydrogen collisions. Hatton, G.J.; Chen, J.C.Y.; Ishihara, T.; Watson, K.M. (Department of Physics and Institute for Pure and Applied Physical Sciences, University of California, San Diego, La Jolla, California 92037). *Phys. Rev., A;* **12**: No. 4, 1281-1296(Oct 1975).

The interaction in the (p^+, H) collision system is examined in terms of the exact H_2^+ and H electronic states. The nonadiabatic interactions between the H_2^+ electronic states which asymptotically go to the n = 1 or n = 2 atomic states are calculated together with the corresponding translational contributions. The question concerning the choice of the space-fixed and rotating atomic bases is investigated in relation to the long-range interactions. The adiabatic-diabatic question is discussed in connection with the noncrossing rule and dynamic correlations between the separated and united atomic states. With the aid of the calculated interactions, the "coupling hypothesis," which states that the nonadiabatic transitions are directly correlated with the closest approach of the electronic state energies, is examined. The characteristic features of the radial and rotational couplings are discussed in a phase-interference model.

5889 Auger-electron and x-ray production in 50- to 2000-keV Ne+Ne collisions. Stolterfoht, N.; Schneider, D.; Burch, D.; Aagaard, B.; Boving, E.; Fastrup, B. (Hahn-Meitner-Institut fur Kernforschung Berlin GmbH, 1 Berlin 39, West Germany). *Phys. Rev., A;* **12**: No. 4, 1313-1329(Oct 1975).

The production of vacancies in the inner and outer shells of the target and projectile have been studied in Ne/subi/$^+$+Ne collisions in the incident energy range of 45 keV to 2.2 MeV through the observation of K x rays and Auger electrons. Data are given for incident charge states i=0, 1, and 2. Parameters necessary for the analysis of collision kinematics were extracted from previous data and used to investigate these effects on the observed Auger

spectra. The kinematic line broadening in the Ne collisions is shown to obscure the peak structure characteristic of the multiple ionization states. The centroid energies and average energy widths of the Auger groups, together with absolute intensities, are reported as a function of the Ne/subi/$^+$ energy and electron emission angle for both target and projectile. Absolute cross sections for x-ray and Auger-electronproduction are reported with an accuracy of about plus-or-minus15%, and mean fluorescence yields are determined from these cross-section data. Information regarding the coupling of outer-shell molecular orbitals in the entrance channel is extracted from the comparison of the measured data and previous calculations.

5890 K-shell Auger-electron hypersatellites of Ne. Woods, C.W.; Kauffman, R.L.; Jamison, K.A.; Stolterfoht, N.; Richard, P. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). *Phys. Rev., A;* **12**: No. 4, 1393-1398(Oct 1975).

The cross section for production of excited Ne ions with double K-shell vacancies is measured by observing the Auger electrons from the decay of these states. A Ne-gas target is bombarded by 1—2-MeV/amu N, O, and F projectiles in various incident charge states. The K-shell Auger hypersatellites are observed only for bare nuclear projectiles. The projectile charge-state dependence, projectile Z dependence, and energy dependence of the cross section suggest K-shell electron exchange as a production mechanism.

5891 Crossed molecular beam study of F + CH_3I. Farrar, J.M.; Lee, Y.T. (Univ. of Chicago). *J. Chem. Phys.;* **63**: No. 8, 3639-3648(15 Oct 1975).

The reaction F + CH_3I yields IF + CH_3 has been studied at two relative collision energies of 2.6 and 14.1 kcal $mole^{-1}$ using the crossed molecular beam technique. Angular and velocity distributions of the reactively scattered IF products have been measured. At the lower collision energy the distributions are consistent with reaction occurring through a complex for which the lifetime is many rotational periods. At the higher collision energy, the complex lives only a fraction of a rotational period. The energy distributions measured for these systems are shown to be fairly consistent with RRKM and phase space statistical models; in order to make a more reliable statistical calculation on this system, the stability of the intermediate complex, CH_3IF, has been determined in independent measurements of the threshold for the reaction F_2 + CH_3I yields CH_3IF + F. (auth)

5892 The elastic and inelastic scattering of diatomic molecules by atoms: CsI+Ar, CsCl+Ar, CsI+Xe. Armstrong, W.D.; Conley, R.J.; Creaser, R.P.; Greene, E.F.; Hall, R.B. (Metcalf Chemical Laboratories, Brown University, Providence, Rhode Island 02912). *J. Chem. Phys.;* **63**: No. 8, 3349-3364(15 Oct 1975).

Measurements of differential cross sections for the elastic and inelastic scattering of CsI by Ar, of CsI by Xe, and of CsCl by Ar are reported at three relative translational energies E in the range 4—17 kJ mol^{-1}. Both excitation and de-excitation of the molecules, which have internal energies approximately those of a gas at 844 K, occur with cross sections approaching those of elastic scattering for center-of-mass angles of 40degree or greater. No rainbow structure is apparent; presumably either E is below the threshold for the transition from orbiting to rainbow scattering, or E is so high that any rainbow structure is obscured by the scattering near the primary beam, or more probably the molecular asymmetry and dipole moment cause complicated trajectories. The absence of structure corresponding to purely vibrational transitions, even when this would be resolved by the apparatus, suggests that a substantial fraction of the inelastic events involve changes in rotational energy.

5893 Effect of electron correlation on the H_2CO—He interaction potential. Garrison, B.J. (Univ. of California, Berkeley); Lester, W.A. Jr.; Siegbahn, P.; Schaefer, H.F. III. *J. Chem. Phys.;* **63**: No. 10, 4167-4170(15 Nov 1975).

A previously reported Hartree-Fock (HF) interaction potential between $H_2CO(^1A_1)$ and $He(^1S)$ is modified through a series of configuration interaction (CI) calculations. The CI contribution is described by a three-term (l = 0,1,2) Legendre polynomial expansion in the angle theta formed by the direction of incidence of He and the CO bond of formaldehyde. No significant azimuthal angle dependence is obtained. Correlation is found to have little effect in the strongly anisotropic repulsive region of the interaction potential but dominates the well and long-range regions. The maximum well depth is attained for in-plane approaches of He and lies in the range 35-40°K for arbitrary theta at center of mass separation of 7.5 a.u. The CI contribution in the region of the minimum is believed accurate to approximately 20 percent. (auth)

ATOMIC AND MOLECULAR THEORY

5894 (CONF-710674—(Absts.)) **Twenty-sixth symposium on molecular structure and spectroscopy, Columbus, Ohio, June 14—18, 1971. Abstracts.** (Ohio State Univ., Columbus (USA)). Jun 1971. 120p. Ohio State Univ., Columbus, Ohio.

From 26. symposium on molecular structure and spectroscopy; Columbus, Ohio, USA (14 Jun 1971).

265 abstracts are presented of papers on molecular structure and spectroscopy. Included in the proceedings are a key to the abstracts, author list, and conference program. (GHT)

5895 (SAND—75-0443) **N-shell Auger, Coster—Kronig and radiative matrix elements, and Auger and Coster—Kronig transition rates in j-j coupling.** McGuire, E.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 98p. Dep. NTIS $6.00.

All the matrix elements used to compute N-shell fluorescence yields are given. Also included are the Auger transition rates in j-j coupling. (54 tables) (auth)

FLUID PHYSICS

PROPERTIES AND STRUCTURE OF FLUIDS

5896 (COO—2203-4) **Critical scattering of laser light by thin fluid films. Technical progress report, February 1, 1975—January 31, 1975.** Mockler, R.; O'Sullivan, W. (Boeing Scientific Research Labs., Seattle, Wash. (USA)). 1975. Contract E(11-1)-2203. 10p. Dep. NTIS $4.50.

The intent of the program was to develop new techniques and approaches to the study of the physical behavior of fluids near second-order phase transitions. Among the accomplishments of the program was the first application of photon autocorrelation techniques to the study of light scattered from microspheres diffusing in critical fluids, from which the behavior of the shear viscosity of a fluid in the critical regime was inferred; the development of the fluid-filled Fabry—Perot etalon, which led to the first measurement of the anomalous index of refraction of a critical fluid; and work on Brownian motion in critical and normal fluids leading to the development of a new model interpretation of Rayleigh scattering studies on critical fluids in general, the Dynamic or Diffusing Droplet Model. Subsequent sections of the report discuss the following topics: the Diffusing Droplet Model interpretation of light scattering from critical fluids; Brownian diffusion in a single-component critical fluid; properties of colloidal crystals; extensions of the fluid-filled Fabry—Perot technique to the study of thin critical fluid films and the anomalous index of refraction of a critical fluid; light scattering from Brownian particles diffusing in the presence of a thermal gradient; dependence upon particle concentration of the diffusion of particles in a fluid; and progress in the development of a Brillouin scattering spectrometer system. (RWR)

MAGNETOHYDRODYNAMICS

5897 MAGNETOHYDRODYNAMIC PRESSURE DROP OF LITHIUM FLOWING IN CONDUCTING WALL PIPE IN A TRANSVERSE MAGNETIC FIELD: THEORY AND EXPERIMENT. Carlson, G.A. Hinsdale, IL; United States of America (USA); American Nuclear Society (1974). vp.

From ANS 1. topical meeting on the technology of controlled nuclear fusion; San Diego, California (16 Apr 1974).

Electrically conducting fluids flowing in strong magnetic fields can suffer large magnetohydrodynamic pressure drops. The ability to calculate accurately these pressure drops is of great importance in the design of a fusion reactor blanket using flowing lithium coolant. The report is concerned with the MHD pressure drop of lithium flowing in a conducting-wall circular pipe in a transverse magnetic field. The ranges of flow parameters chosen for consideration encompass the expected fusion reactor applications. In all cases the lithium flow is expected to be laminarized by the magnetic field. (auth)

SUPERFLUIDITY

5898 Phase transitions in systems with a coupling to a nonordering parameter. Achiam, Y.; Imry, Y. (Department of Physics and Astronomy, Tel-Aviv University, Tel-Aviv, Israel). *Phys. Rev., B;* **12**: No. 7, 2768-2776(1 Oct 1975).

The renormalization-group method is applied to the analysis of phase transitions in systems where the order parameter s coupled to a nonordering additional variable y. A variety of critical

and tricritical behaviors or first-order transitions is found as a function of the physical variables and possible macroscopic constraints imposed on the system. For s^2y coupling, the correlation function of y was found to be governed by a correlation length which is proportional to that of the order parameter, and by a critical index eta/suby/center-dot eta/suby/=2-2α; α here is the specific-heat exponent of the appropriate unconstrained system. The singular part of the susceptibility, chi/suby/, has a critical exponent equal to α, the true specific-heat exponent. When the coupling is s^2y^2, a weaker singularity of chi/suby/ appears. The crossover between this behavior and the one typical to s^2y coupling is calculated. <y> has a singular part with an exponent 1-α, in the unconstrained case. The breakdown of the scaling law related to the correlation function of y in the constrained case is discussed.

5899 Nonlinear parallel ringing of magnetization in superfluid ^{3}He. Webb, R.A.; Sager, R.E.; Wheatley, J.C. (University of California at San Diego, La Jolla, California 92037). *Phys. Rev. Lett.*; 35: No. 15, 1010-1013(13 Oct 1975).

Experiments based on an analogy to the ac Josephson effect have shown in both ^{3}He-A and ^{3}He-B that a pairing theory of the superfluidity of ^{3}He is essentially correct. Additional observations of parallel ringing are not in agreement with the simple "pendulum models" used to describe nonlinear dynamic magnetic effects.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

5900 (BNL—20465) **Search for fractionally charged quarks at ISABELLE.** Foley, K.J.; Meadows, B.T. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 11p. (CONF-750737—2). Dep. NTIS $4.50.

From Proceedings of the ISABELLE summer study; Upton, New York, USA (14 Jul 1975).

A relatively simple experiment is proposed which is sensitive to conventional quarks of charge 1/3 or 2/3e and mass less than 200 GeV. The experiment uses a modest amount of conventional equipment, no magnetic momentum analysis, and in a period of one week will achieve a sensitivity of 10^{-34}cm^2 to isotropic quark production. Despite the experimental simplicity, the signature provided by a fractionally charged quark should be unambiguous. The method and apparatus are described, background and counting rates are discussed, and finally a cost estimate is given for this experiment. (JFP)

5901 (COO—3539-6) **Experimental investigation of pion decays at the Clinton P. Anderson Meson Physics Facility. Progress report, September 1, 1974—August 31, 1975.** Auerbach, L.B.; Highland, V.L.; McFarlane, W.K. (Temple Univ., Philadelphia, Pa. (USA). Dept. of Physics). 1975. Contract AT(11-1)-3539. 11p. Dep. NTIS $4.50.

The π^0 spectrometer to be used in the pion beta-decay experiment (LAMPF experiment 32) was fully tested at LAMPF using the charge exchange reaction π^- p yields π^0n. Enough data is in hand to provide a satisfactory π^0 efficiency calibration, and to guide improvements in the apparatus and computer programs. The full pion beta-decay apparatus was assembled on the P^3 beam line last summer in a period of less than two weeks, and was operated to determine sources of backgrounds and accidental rates. Several changes are underway in this apparatus, but running has been postponed until a primary beam of the order of 300 μA is available from LAMPF. Preparations for the π^0 yields 3γ experiment (LAMPF experiment 144) are now actively underway, and one expects them to be substantially complete this summer. A collaboration was begun with the University of New Mexico group (D. Wolfe et al) on problems of nucleon—nucleon scattering (i.e., on neutron-proton elastic scattering and single pion production in proton-proton scattering-LAMPF experiments 193 and 124). These proposals have now been approved and scheduled. (auth)

5902 (ERDA—83) **Report of the 1975 subpanel on new facilities of the High Energy Physics Advisory Panel.** (Energy Research and Development Administration, Washington, D.C. (USA)). Jul 1975. 30p. Dep. NTIS $5.00.

The topics discussed are new developments in particle physics, physics at the proposed new facilities, technical considerations, recommendations and comments, and the impact of alternative funding levels. (JFP)

5903 (UCSC—34P197X4) **Experimental research in high energy physics. Progress report.** Heusch, C. (California Univ., Santa Cruz (USA)). 1975. Contract E(04-3)-34. 8p. Dep. NTIS $4.50.

Research on experimental high energy physics is summarized. A list of publications is included. (JFP)

ELECTROMAGNETIC INTERACTIONS

5904 (LBL—4289) **Status of searches for magnetic monopoles.** Eberhard, P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 8 Oct 1975. Contract W-7405-Eng-48. 6p. (CONF-750858—12). Dep. NTIS $4.50.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

The recent experiment reporting the discovery of a monopole is compared to the negative experiments performed previously. The different determinations of the flux of monopoles are contradictory. It is likely that the event reported as a monopole may be given another interpretation. (auth)

5905 (LBL—4311) **Experimental status of high-spin states.** Stephens, F.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-Eng-48. 28p. (CONF-750976—1). Dep. NTIS $5.00.

From Conference on highly excited states of nuclei; Julich, F.R. Germany (22 Sep 1975).

Changes occurring in high spin nuclear states are discussed. Experimental methods for studying reduction and eventual quenching of pairing interactions, changes in nuclear shapes, and alignment of individual particle angular momenta with increasing spin are reviewed. Emphasis is placed on the study of continuum gamma rays following heavy ion reactions. (12 figures) (SDF)

5906 (SLAC—185) **Electron scattering off hydrogen and deuterium at 50° and 60°.** Atwood, W.B. (Stanford Linear Accelerator Center, Calif. (USA)). Jun 1975. Contract E(04-3)-515. 251p. Dep. NTIS $7.50.

Thesis.

The inelastic scattering of electrons for both protons and neutrons has been measured at scattering angles of fifty and sixty degrees and for incident energies between 6.5 GeV and 19.5 GeV. Elastic scattering from protons was also observed. The measurements were made at the Stanford Linear Accelerator Center using the 1.6-GeV spectrometer located in End Station A. The experimental techniques used in making the measurements are detailed. The resulting cross sections are large, indicative of a charged point-like substructure within the nucleon and match the extrapolation from previous measurements to the kinematic region to within forty percent. The measurements are found to be compatible with some existing theoretical expectations. The W_1 structure function is not found to "scale" in previously suggested scaling variables. The introduction of propagator scale breaking is investigated and shown to be compatible with the measurements. An alternative scaling variable is proposed in which W_1 is found to scale. The elastic scattering measurements are consistent with an inverse fourth power dependence on four-momenta transfer. The measured neutron-proton ratio is in agreement with previous measurements. (55 figures, 27 tables) (auth)

5907 Search for structure in the γ-ray spectra from anti-pd and anti-pp annihilations at rest. Kalogeropoulos, T.E.; Michael, D.N.; Lowenstein, D.I.; Nathan, A.M.; Samios, N.P.; Schwarzschild, A.Z. (Department of Physics, Syracuse University, New York 13210). *Phys. Rev. Lett.*; 35: No. 13, 824-827(29 Sep 1975).

The γ-ray spectra from annihilations at rest have been measured with a 10-in.times10-in.-diam NaI(Tl) detector. The resolution of the system was ~15% for γ-ray energies between 50 and 200 MeV. No clear evidence is found for monoenergetic γ rays with intensities greater than 1 per 30 annihilations.

5908 Quest for the magnetic monopole. Carrigan, R.A. Jr. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Teach.*; 13: No. 7, 391-398(Oct 1975).

A brief review is given of the properties of the magnetic monopole and of the experimental efforts to detect the postulated particle. (AIP)

5909 Radiative decays of eta and eta' as probes of quark charges. Chanowitz, M.S. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.*; 35: No. 15, 977-980(13 Oct 1975).

Radiative decays of eta and eta' allow us to test the color hypothesis and to distinguish between fractional- and integral-charge quark models. Accurate measurements of eta'yields$\gamma\gamma$ and eta'yields$\pi^+\pi^-\gamma$ are essential to test the analysis and the preliminary conclusion, which favors the three-color model with fractional charges.

WEAK INTERACTIONS

5910 (ANL/HEP-CP—75-38) **Inclusive look at νp and νn charged-current reactions below 6 GeV.** Barish, S.J.; Derrick, M.;

Barnes, V.E. (Argonne National Lab., Ill. (USA); Purdue Univ., Lafayette, Ind. (USA)). 1975. 30p. (CONF-750853—3). Dep. NTIS $4.50.

From Symposium on lepton and photon interactions; Stanford, California, USA (21 Aug 1975).

A study is made of inclusive charged-current νp and νn reactions by summing exclusive reactions. A broad-band neutrino beam of energies up to 6 GeV/c is used. Both the νn and νp total cross sections are found to rise with energy, and the neutron-to-proton cross section ratio is measured to be 1.40 +- 0.31 for E/sub ν/ greater than 2 GeV. The X and Y distributions and the cross sections for quasi-elastic scattering, single π, 2 π, and 3 π production are discussed. The results given are preliminary. (JFP)

5911 (ANL/HEP-CP—75-39) **Antineutrino—proton interactions in the 15-foot bubble chamber.** Barish, S.J.; Derrick, M.; Dombeck, T. (Argonne National Lab., Ill. (USA)). 1975. 26p. (CONF-750853—1). Dep. NTIS $5.00.

From Symposium on lepton and photon interactions; Stanford, California, USA (21 Aug 1975).

From 24,000 pictures of the Fermilab 15-foot hydrogen bubble chamber exposed to a broad band anti ν beam, there were 89 anti νp yields $\mu^+ + X^0$ events with a total momentum in the charged tracks greater than 5 GeV/c obtained. The techniques used to identify the muon are discussed, and the anti ν energy is estimated. The charged particle multiplicity distributions and the mean π^0 multiplicity are presented. The semi-inclusive X, Y, Z, Q^2 and W distributions are compared with model predictions. The rate of strange particle production is measured. No evidence was found for charm particle production. (auth)

5912 **psi (3684) radiative decays to high-mass states.** Feldman, G.J.; Jean-Marie, B.; Sadoulet, B.; Vannucci, F.; Abrams, G.S.; Boyarski, A.M.; Breidenbach, M.; Bulos, F.; Chinowsky, W.; Friedberg, C.E.; Goldhaber, G.; Hanson, G.; Hartill, D.L.; Johnson, A.D.; Kadyk, J.A.; Larsen, R.R.; Litke, A.M.; Luke, D.; Lulu, B.A.; Luth, V.; Lynch, H.L.; Morehouse, C.C.; Paterson, J.M.; Perl, M.L.; Pierre, F.M.; Pun, T.P.; Rapidis, P.; Richter, B.; Schwitters, R.F.; Tanenbaum, W.; Trilling, G.H.; Whitaker, J.S.; Winkelmann, F.C.; Wiss, J.E. (Lawrence Berkeley Laboratory and Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev. Lett.*; 35: No. 13, 821-824(29 Sep 1975).

We present experimental evidence for the existence of the decay psi (3684) yieldsγ,chi, chiyields4π/sup plus-or-minus/, 6π/sup plus-or-minus/, $\pi^+\pi^-K^+K^-$, $\pi^+\pi^-$, and K^+K^-. There is clear evidence for at least two chi states, one at 3.41plus-or-minus0.001 GeV/c^2 and the other at 3.53plus-or-minus0.02 GeV/c^2. The chi (3410) decays into $\pi\pi$ and KK and thus must have even spin and parity.

STRONG BARYON-INDUCED INTERACTIONS

5913 (CONF-750858—4) **Inclusive neutral particle production.** Kahn, S. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). 1975. 6p. Dep. NTIS $4.00.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

Results of recent inclusive neutral particle production experiments are compared to existing experimental results. These experiments range from 15 to 2000 GeV/c in laboratory beam momentum and use π^-, π^+, p and anti p beams. (auth)

5914 (COO—3065-124) **Studies of neutron dissociation at FermiLab energies.** Ferbel, T. (Rochester Univ., N.Y. (USA). Dept. of Physics and Astronomy). 21 Aug 1975. Contract E(11-1)-3065. 41p. (UR—546). Dep. NTIS $5.00.

The characteristics of diffraction dissociation of neutrons into $p\pi^-$ systems at high energies were examined. A substantial correlation is observed between the mass and the t of the produced system. The spin structure of the $p\pi^-$ amplitudes at low mass is very complex, but is described surprisingly well by the simple Deck Mechanism. Both π-exchange and proton-exchange contributions are evident in diffractive production. The t-channel and s-channel helicity amplitudes contain comparable contributions from flip and nonflip terms and the produced states are not restricted to those expected on the basis of the Morrison rule. (auth)

5915 (COO—3130-TB-211) **Angular distributions of anti pp yields $\pi^0\pi^0$ and anti pp yields π^0eta^0 at 1.752 GeV/c.** DeMarzo, C.; Guerriero, L.; Posa, F. (Brown Univ., Providence, R.I. (USA). Dept. of Physics). 1973. 33p. (CONF-7406110—1; CONF-740713—42). Dep. NTIS $4.75.

From Symposium on antinucleon-nucleon interactions; Prague, Czechoslovakia (24 Jun 1974).

An experiment was performed to measure the angular distributions in the reactions anti pp yields $\pi^0\pi^0$ and yields π^0eta^0 at an incident anti p momentum of 1.752 GeV/c. Structure is seen in the angular distributions for both reactions. These data are combined with those of Eisenhandler et al., on anti pp yields $\pi^+\pi^-$ to determine the angular distributions in the states I/sup G/ = 0^+ and I/sup G/ = 1^+; pronounced structure is seen in both states which differ significantly from that of π^0 eta^0 (I/sup G/= 1^-). (auth)

5916 (UCI—34P149X4) **High energy physics studies. Progress report, October 1, 1974—September 30, 1975.** Condon, P.E.; Schultz, J. (California Univ., Irvine (USA). Dept. of Physics). 1975. Contract AT(04-3)-34. 71p. Dep. NTIS $5.50.

Progress is reported on research conducted by the High Energy Physics Group of the Irvine campus of the University of California, during the contract year beginning October 1, 1974. Work was performed on six projects: Completion of the analysis of proton-antiproton interactions between 0.1 and 1.1 GeV/c, analysis of an exposure in the 30 inch BNL bubble chamber with deuterium fill, running and analysis of an experiment to study K^0/sub L/p interactions in the momentum range 2 to 6 GeV/c, preparation of an experiment to study production of massive mu pairs in K^0/sub L/-nucleon interactions, preparation of an experiment to study direct electron production at SLAC-SPEAR, analysis of small angle pp data from CERN-ISR. (auth)

5917 **Study of diffraction dissociation in 19 and 28 GeV/c pd interactions.** Hanlon, J.; Panvini, R.; Waters, J.; Webster, M.; Morris, T.W. (Vanderbilt University, Nashville, Tennessee 37235). *Phys. Rev., D;* 12: No. 3, 673-680(1 Aug 1975).

The reaction pd yields p)pπ^-p is studied at 19 and 28 GeV/c with data from the Brookhaven National Laboratory 80-in. deuterium-filled bubble chamber. In addition, a separate study is made of the low-momentum pion spectra in selected low-multiplicity events presumed to be associated with either of two isospin-conjugate modes of deuteron fragmentation by a 28-GeV/c beam proton. Our results from these complementary studies are that low-multiplicity channels are dominantly of a diffractive nature; however, significant differences seen in the mass spectra and angular correlations in the slow $p\pi^-$ between the 19- and 28-GeV/c data indicate that asymptotic behavior has not been reached, as least at 19 GeV/c. Neither s- nor t-channel helicity conservation is seen in the excitation of the target neutron into a low-mass $p\pi^-$ system. The N* (1.4) of missing-mass experiments is shown to be a superposition of nucleon-pion and nucleon—two-pion states.

5918 **Charge dispersion and recoil properties at A=131 from the interaction of ^{197}Au with 11.5- and 300-GeV protons.** Yu, Y.W.; Porile, N.T. (Department of Chemistry, Purdue University, Lafayette, Indiana 47907). *Phys. Rev., C;* 12: No. 3, 938-947(Sep 1975).

Cross sections and thick-target recoil properties of five nuclides with A=131 as well as those of a number of neighboring nuclides have been determined for the interaction of ^{197}Au with 11.5-GeV protons. The charge dispersion at A=131 has a single peak at Z/subA/-Z=-3.5 and the total isobaric cross section is 8.9plus-or-minus0.8 mb. The ranges indicate that only ~2% of this value can be ascribed to fission, the bulk of the cross section involving a deep spallation process. Similar data have been obtained at 300 GeV. Within the limits of error the results are the same at both energies. The systematics of deep spallation reactions are examined.

5919 **Excitation of high-energy protons into low-mass states in p-d interactions.** Akimov, Y.; Cool, R.; Golovanov, L.; Goulianos, K.; Gross, D.; Melissinos, A.; Malamud, E.; Mukhin, S.; Nitz, D.; Olsen, S.; Sticker, H.; Takhtamyshev, G.; Tsarev, V.; Yamada, R.; Zimmerman, P. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev. Lett.*; 35: No. 12, 763-766(22 Sep 1975).

p-d inelastic scattering has been measured at small momentum transfer by detecting the slow-recoil deuterons from a deuterium-gas-jet target. The coherent diffraction dissociation of protons on deuterons was studied in the region 0.03<vertical-bartvertical-bar<0.07 (GeV/c)^2, 1.4<M)^2<4 GeV^2, and for energies from 50 to 275 GeV. In this region, the diffractive cross section exhibits structure and is dominated by an enhancement at M)^2~1.9 GeV^2.

5920 **Diffraction dissociation of high-energy protons in p-d interactions.** Akimov, Y.; Cool, R.; Golovanov, L.; Goulianos, K.; Gross, D.; Melissinos, A.; Malamud, E.; Mukhin, S.; Nitz, D.; Olsen, S.; Sticker, H.; Takhtamyshev, G.; Tsarev, V.; Yamada, R.; Zimmerman, P. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev. Lett.*; 35: No. 12, 766-770(22 Sep 1975).

Results are reported from a measurement of the inclusive process p+dyieldsX+d in the region 0.03<vertical-bartvertical-bar<0.12 (GeV/c)^2 and 5 GeV^2<M)^{2}approximately-less-

than0.11p) for incident proton momenta from 150 to 400 GeV/c. We find that in this region, the differential cross section $d^2\sigma/dt\,dM)^2$ varies only slowly with energy, falls exponentially with vertical-bartvertical-bar, and behaves to a good approximation as $1/M)^2$. The measurement was performed at Fermilab by detecting slow-recoil deuterons from a deuterium-gas-jet target placed at the internal beam of the accelerator.

5921 Observation of a difference between polarization and analyzing power in Λ^0 production with 6-GeV/c polarized protons. Lesnik, A.; Schwartz, D.M.; Ambats, I.; Hayes, E.; Meyer, W.T.; Ward, C.E.W.; Knasel, T.M.; Swallow, E.G.; Winston, R.; Romanowski, T.A. (Ohio State University, Columbus, Ohio 43210). *Phys. Rev. Lett.;* **35**: No. 12, 770-772(22 Sep 1975).

The polarization, analyzing power, and depolarization parameter have been measured for forward Λ^0/sup ^{7}/s produced with a 6-GeV/c polarized-proton beam at the Argonne National Laboratory zero-gradient synchrotron. We collected a sample of 15 281 Λ^0 production events with subsequent $p\pi^-$ decays. There is a clear difference between the polarization and analyzing power for events with Feynman scaling variable chi greater than 0.8. This is the first observation of this phenomenon at high energy.

5922 Inclusive Δ^{++} production in π^+p and pp interactions at 100 GeV/c and the average multiplicity of $\pi^+\pi^-$ scattering. Erwin, J.; Kass, R.D.; Klems, J.H.; Ko, W.; Lander, R.L.; Pellett, D.E.; Yager, P.M.; Alston-Garnjost, M. (Department of Physics, University of California, Davis, California 95616). *Phys. Rev. Lett.;* **35**: No. 15, 980-982(13 Oct 1975).

Inclusive Δ^{++}(1236) production in π^+p and pp interactions is consistent with one-pion exchange. The average charged multiplicity recoiling from the Δ^{++} is studied as a function of missing mass, M^2, for both interactions.

STRONG MESON-INDUCED INTERACTIONS

5923 (CONF-750858—2) **Searches for charmed particles using bubble chambers.** Harris, R. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Oct 1975. 5p. Dep. NTIS $4.50.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

Searches for charm particle production using bubble chambers are summarized. These searches depend on the detection of neutral strange particles. Upper limits are given for the different charmed mass regions and methods of search. (auth)

5924 (CONF-750869—2) **Neutral strange particle production in π tau interactions at 250 GeV/c.** Bogert, D.; Hanft, R.; Harris, R. (Fermi National Accelerator Lab., Batavia, Ill. (USA); Florida State Univ., Tallahassee (USA)). 1975. 14p. Dep. NTIS $4.50.

From Division of particle and fields meeting; Seattle, Washington, USA (Aug 1975).

Neutral strange particles were studied in about one third of a 46,000 picture exposure of 250-GeV/c pions in the Fermilab 15 foot bubble chamber. This chamber is particularly well suited for the study of neutral particles because of its large volume. Experimental inclusive cross sections are sigma (K/sub s/^{0}) equals 4.17 +- 0.45 mb, sigma (LAMBDA^0) = 1.74 +- 0.24 mb, sigma (anti LAMBDA^0) = 0.82 +- 0.13 mb. The average number of K/sub s/^{0}, LAMBDA^0, anti LAMBDA^0 per inelastic collision are approximately independent of charge multiplicity. $F_1(x)$ and F_2(p/sup 2// sub t/) distributions as well as two strange particle mass plots are presented. (auth)

5925 (CONF-750869—3) **Topological cross sections and multiplicity moments for π^-p interactions at 250 GeV/c.** Hagopian, S.; Albright, J.R.; Hays, P. (Florida State Univ., Tallahassee (USA); Fermi National Accelerator Lab., Batavia, Ill. (USA)). 1975. 14p. Dep. NTIS $4.50.

From Division of particle and fields meeting; Seattle, Washington, USA (Aug 1975).

The data are from a 46,000 picture exposure of the 15-foot hydrogen bubble chamber at Fermilab to a 250-GeV/c π^-run. An inelastic cross section of 21.1 +- 0.6 mb was obtained. Topological cross sections and multiplicity moments are presented and compared with results at lower energies. The energy dependence of the mean charged multiplicity, (n), and the second moment, f_2, are well fit by a polynomial in log's for π^-p experiment from 10 to 250 GeV/c. (auth)

5926 (FSU-HEP—75-1-03) **Four charged particle final states from the reaction π^+d at 15 GeV/c.** Pewitt, N.D. (Florida State Univ., Tallahassee (USA)). Jan 1975. 177p. Dep. NTIS $8.50.

Thesis.

The data from 387,000 stereotriplet photographs of the deuterium filled Stanford Linear Accelerator Center 82-inch bubble chamber exposed to a 15-GeV/c π^+ separated beam is presented. The film was measured on a Flying Spot Digitizer with an accuracy of one micron. The final states $\pi^+\pi^-$pp, $\pi^+\pi^-\pi^0$pp, $\pi^+\pi^+\pi^-$np, $\pi^+\pi^+\pi^-$d and $\pi^+\pi^+\pi^-\pi^0$d are discussed. With an experimental sensitivity of 4.75 +- .09 events/μb there is no new boson resonance structure in these data. The one-pion-exchange process dominates the breakup reactions. A rising (3π) coherent cross section established by these data is explained in terms of a kinematical effect. The data were used in a search for direct evidence for nuclear isobar ($\Delta\Delta$) component of the deuteron and established an upper limit at about one per cent. Details of the experimental procedure and the data reduction are described as well as an alternate data processing system, RESURX, which allows human intervention in the pattern recognition process to save over half the events failed by the normal data reduction system. (auth)

5927 (LBL—4299) **K^-p and anti pp charge exchange cross sections below 1.1 GeV/c.** Alston-Garnjost, M.; Kenney, R.; Pollard, D.; Ross, R.; Tripp, R.; Nicholson, H.; Ferro-Luzzi, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-Eng-48. 7p. (CONF-750858—11). Dep. NTIS $4.50.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

The cross sections are measured for K^-p yields anti K^0n at 520 to 1060 MeV/c and for anti pp yields anti nn from 270 to 960 MeV/c with a typical point-to-point precision of about 1 percent. The cross sections in preliminary form are shown and discussed. It is suggested that the spin of the $\Sigma(1590)$ must be at least $^3/_2$ and that of a possible resonance at the bump at 475 MeV/c must be at least 4. (JFP)

5928 Charge asymmetry in inelastic π^-p interactions at 205 GeV/c for particles with transverse momentum > 1.0 Gev/c. Fretter, W.B.; Graves, W.R.; Bingham, H.H.; Chew, D.M.; Daugeras, B.Y.; Johnson, A.D.; Kadyk, J.A.; Stutte, L.; Trilling, G.H.; Winkelmann, F.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Phys. Lett., B;* **57**: No. 2, 197-200(23 Jun 1975).

5929 KK system in π^-pyieldsK$^-$K$^+$n at 6 GeV/c. Pawlicki, A.J.; Ayres, D.S.; Diebold, R.; Greene, A.F.; Kramer, S.L.; Wicklund, A.B. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **12**: No. 3, 631-637(1 Aug 1975).

The reaction π^-pyieldsK$^-$K$^+$n has been studied at 6 GeV/c with a 16 000 event data sample obtained with the Argonne National Laboratory Effective Mass Spectrometer. Moments of the K$^-$K$^+$ decay angular distributions are shown as functions of the K$^-$K$^+$ effective mass from threshold to 1500 MeV, and as functions of momentum transfer from t) to -0.4 GeV^2. The t-channel moments <Y/subl//subm/> with m=0 dominate over the m=1 moments, while moments with mgreater than or equal to2 (and those with lgreater than or equal to6) are negligible; this indicates that the dominant t-channel exchange production amplitudes have helicity zero at the meson vertex. The slope of $d\sigma/dt$ decreases as the K$^-$K$^+$ mass increases. There is a broad D-wave enhancement near 1350 MeV. Interfering f and A_2^0 D-wave Breit-Wigner resonances are not sufficient to explain all of the Y_4^0 distribution above 1350 MeV and an additional D-wave contribution may be present. Ignoring this complication, the best f-A_2^0 fit to the Y_4^0 spectrum yields a branching ratio (fyieldsKK)/(fyieldsall) = (3.1plus-or-minus1.0) %.

5930 Vector meson + baryon resonance production in π^+p interactions at 7.1 GeV/c. Chung, S.U.; Protopopescu, S.D.; Eisner, R.L.; Flatte, S.M. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **12**: No. 3, 693-718(1 Aug 1975).

From a large-statistics π^+p experiment at 7.1 GeV/c, data are presented on the reactions π^+yieldsrho$^0\Delta^{++}$(1238) and π^+p yields$\omega\Delta^{++}$(1238). Cross sections, differential cross sections, and vector-meson single-density-matrix elements are presented and a general comparison of the production properties of the two reactions is given. In addition to (rho,ω) Δ^{++}(1238) production there is also strong evidence for production of a π^+p enhancement with mass ~1880 MeV, Γ~200 MeV, and Jgreater than or equal to7/2 produced in association with the rho and ω resonances. Detailed properties of this structure are presented and its production mechanism is compared with that of the corresponding Δ (1238) reactions. This state is also observed in the reaction K$^+$pyieldsK^{*0} (890) Δ^{++}(1880) at 12.0 GeV/c, for which data are also presented.

5931 Search for narrow neutral-meson resonances near mass 1 GeV/c^2. Buttram, M.; Crawley, H.B.; Duke, D.W.; Lamb, R.C.; Leeper, R.J.; Peterson, F.C. (Ames Laboratory: ERDA and Department of Physics, Iowa State University, Ames, Iowa 50010). *Phys. Rev. Lett.;* **35**: No. 14, 970-973(6 Oct 1975).

We examine the reaction π^-pyieldsX^{0}n at 2.4 GeV/c for evidence of the production of the previously reported narrow

neutral mesons $M^0(940)$, δ (963), $M^0(1033)$, and $M^0(1150)$. Strong evidence against the existence of these states is presented.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

5932 (COO—2271-61) **Theoretical high energy physics. Renewal proposal and research report, October 1, 1975—September 30, 1976.** Lee, T.D.; Serber, R. (Columbia Univ., New York (USA)). May 1975. Contract AT(11-1)-2271. 27p. Dep. NTIS $5.00.

Research on nuclear, atomic, and high energy physics is summarized. A list of publications is included. (JFP)

5933 (COO—3065-125) **Suggestion for testing the hypothesis of local compensation of transverse momentum.** Weingarten, D. (Rochester Univ., N.Y. (USA). Dept. of Physics and Astronomy). 22 Aug 1975. Contract E(11-1)-3065. 8p. (UR—547). Dep. NTIS $4.50.

An experimental test of the hypothesis of local compensation of transverse momentum in multiparticle production is described. (auth)

5934 (FERMILAB-Conf—75/63) **Agenda for correlations.** Quigg, C. (Fermi National Accelerator Lab., Batavia, Ill. (USA); European Organization for Nuclear Research, Geneva (Switzerland)). Aug 1975. 9p. (CONF-750742—1). Dep. NTIS $4.00.

From 6. international colloquium on multiparticle dynamics; Oxford, UK (Jul 1975).

A brief discursive summary of the structure of events; and for particle interactions some unanswered questions are presented. (auth)

5935 (FERMILAB-Conf—75/71-THY) **Review of models with more than four quarks.** Barnett, R.M. (Fermi National Accelerator Lab., Batavia, Ill. (USA); Harvard Univ., Cambridge, Mass. (USA). Lyman Lab. of Physics). Sep 1975. 34p. (CONF-750842—2). Dep. NTIS $5.00.

From 6. topical conference in particle physics; Honolulu, Hawaii, USA (6 Aug 1975).

Several models with more than four quarks are reviewed and compared with the four-quark model. They generally have right- and left-handed currents and are of the $SU_2 \times U_1$ type. The lepton sectors are also discussed including the possibilities of heavy charged and neutral leptons. The weak phenomenology, triangle anomalies, degenerate quark masses and radial excitations are examined. (auth)

5936 (FERMILAB-Conf—75/72-THY) **Review of gauge theories.** Lee, B.W. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Sep 1975. 37p. (CONF-750855—7). Dep. NTIS $5.00.

From International symposium on lepton and photon interactions at high energies; Stanford, California, USA (21 Aug 1975).

A review is given of gauge theories including an outline of two outstanding issues in the theory of nonleptonic weak interactions, a summary of analyses of higher-order weak interactions based on gauge theory, the mass scale set by the fourth quark, model building incorporating V + A currents. Motivations for such enterprises are emphasized. (JFP)

5937 (LBL—4237) **Color and experimental physics.** Chanowitz, M.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 20 Aug 1975. Contract W-7405-ENG-48. 32p. (CONF-750858—7). Dep. NTIS $4.75.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

After a brief review of the color hypothesis and the motivations for its introduction, the experimental tests arare discussed. It is assumed that colored states have not been produced at present energies and only experimental tests which apply below the color threshold, when color is a "hidden symmetry," are discussed. Some of these tests offer the possibility of distinguishing between quark models with fractional and integral quark charges. (auth)

5938 **Energy scales and diffraction scattering.** Dash, J.W.; Koplik, J. (Institute of Theoretical Science, Department of Physics, University of Oregon, Eugene, Oregon 97403 and High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **12**: No. 3, 785-791(1 Aug 1975).

The influence of thresholds on models of diffraction scattering is considered. We use the experimental existence of effective inelastic diffraction and baryon-antibaryon thresholds to conjecture a relationship between the bare Pomeron P), of the Gribov calculus, the bare Pomeron P) of recent fits to Fermilab—CERN-ISR elastic data, and a bare Pomeron P of intercept alpha-circumflex$_0 \cong 0.85$ utilized in medium-energy two-body and high-energy inclusive phenomenology. A set of energy scales is set up decsribing approximate regions of validity of various models for diffraction, including the Gribov calculus. An iterative approximation scheme to the s- and t-channel unitarity equations at small t and large s is described.

5939 **Local quantum-number compensation in multiple production.** Quigg, C. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **12**: No. 3, 834-840(1 Aug 1975).

Experimental distributions are defined which are sensitive to the existence and nature of short-range phenomena. Clustering of produced hadrons is established directly. The possibility that clusters responsible for strange particle or baryon production differ from those responsible for pion production is entertained. Similarities and distinctions between transverse momentum and other additive quantum numbers are discussed.

5940 **Scalar binding of quarks.** Critchfield, C.L. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). *Phys. Rev., D;* **12**: No. 3, 923-925(1 Aug 1975).

A scalar potential which is linear in the radius is used to confine relativistic individual quark states. Calculation results are compared with those of the "bag" model.

5941 **Relativistic effects in bound-state form factors.** Woloshyn, R.M. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., C;* **12**: No. 3, 901-908(Sep 1975).

The formalism for bound-state form factors in a three-dimensional relativistic theory is used to expose the theoretical limitations of recent work on meson exchange currents. The pair excitation and recoil emission currents used in phenomenological calculations are found to have little theoretical support. The constraints imposed by the Ward identity are examined and the singularity structure of the form factor in relativistic and nonrelativistic theories is compared.

5942 **Exact classical solution for the 't Hooft Monopole and the Julia-Zee dyon.** Prasad, M.K.; Sommerfield, C.M. (Sloane Physics Laboratory, Yale University, New Haven, Connecticut 06520). *Phys. Rev. Lett.;* **35**: No. 12, 760-762(22 Sep 1975).

An exact solution to the nonlinear field equations which describe a classical excitation possessing magnetic and electric charge has been presented. This solution has finite energy and exhibits explicitly those properties which have previously been found by numerical analysis.

ELECTROMAGNETIC INTERACTIONS

5943 (COO—2171-54) **Radiative pion-proton scattering in the static Chew—Low model.** Ho-Kim, Q.; Lavine, J.P. (Laval Univ., Quebec City (Canada). Dept. de Physique; Rochester Univ., N.Y. (USA). Dept. of Physics and Astronomy). 1975. 12p. Dep. NTIS $4.50.

The results of a nonrelativistic calculation of π/sup +-/- proton bremsstrahlung cross sections at the pion laboratory kinetic energy of 298 MeV for backward photon angles is presented. The πp interaction is described by the static Chew-Low model. (auth)

5944 (ORO—3992-236) **Magnetic monopoles and distorted gauge symmetry.** Hsu, J.P. (Texas Univ., Austin (USA). Center for Particle Theory). Oct 1975. 10p. Dep. NTIS $4.50.

It is shown that magnetic monopoles occur in massive vector boson theory with an intrinsic symmetry breakdown while still possessing distorted gauge symmetry. The exact static spherically symmetric solutions for the monopole are obtained. Their meaning is discussed on the basis of gauge symmetry. (auth)

5945 **Measurement of the electron—deuteron elastic-scattering cross section in the range 0.8less than or equal toq^2less than or equal to6 GeV^2.** Arnold, R.G.; Chertok, B.T.; Dally, E.B.; Grigorian, A.; Jordan, C.L.; Schutz, W.P.; Zdarko, R.; Martin, F.; Mecking, B.A. (American University, Washington, D. C. 20016). *Phys. Rev. Lett.;* **35**: No. 12, 776-779(22 Sep 1975).

Preliminary results are reported of elastic e-d scattering at large momentum transfer performed at the Stanford Linear Accelerator Center with use of two high-resolution spectrometers in coincidence. Our results are in sharp disagreement with the meson-exchange calculations, they are in rough agreement with the nonrelativistic potential models, and they are in agreement with the

predictions of the quark dimensional-scaling model which pictures the deuteron as a bound state of six quarks at large momentum transfer.

5946 Leptonic processes in a scalar model of weak interactions. Dicus, D.A.; Teplitz, V.L. (Center for Particle Theory, University of Texas, Austin, Texas 78712). *Phys. Rev. Lett.;* **35**: No. 12, 807-810(22 Sep 1975).

ν/sub mu/e scattering, phi/sube/e scattering, e^+e^-yields$\mu^+\mu^-$ asymmetry, and e^+e^-yields$\mu^+\mu^-$ muon polarization are calculated for a renormalizable model of weak interactions mediated by scalar bosons B/sup plus-or-minus/, B^0, and $\bar{B}^0$. The The predictions differ considerably from those of other weak-interaction theories.

WEAK INTERACTIONS

5947 (BNL—20433) **Consequences of unitarity and analyticity for weak interactions.** Dicus, D.A.; Teplitz, V.L. (Texas Univ., Austin (USA). Center for Particle Theory; Brookhaven National Lab., Upton, N.Y. (USA); Virginia Polytechnic Inst., Blacksburg (USA). Dept. of Physics). 1975. 14p. (CONF-750955—1). Dep. NTIS $4.00.

From Conference on gauge theories and modern field theory; Boston, Massachusetts, USA (26 Sep 1975).

One considers the implications of the fact that weak two body scattering amplitudes, when calculated to all orders in any renormalizable model, should exhibit unitary, analytic, "Mandelstam" behavior. One discusses from this point of view, the existence of neutral currents, the suppression of ν/sub μ/e elastic scattering, and the possibility of lepton hadron resonances. A brief review is given of the predictions for lepton—lepton scattering of two models in which Mandelstam behavior is explicitly realized. (auth)

5948 (COO—1428-426) **Comparison of νp and νn inclusive charged-current reactions below 6 GeV.** Garfinkel, A.F. (Purdue Univ., Lafayette, Ind. (USA)). 1975. 3p. (CONF-750858—9). Dep. NTIS $4.50.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

An analysis of inclusive charged-current ν interactions in the Argonne National Laboratory 12-foot bubble chamber by the ANL-Purdue collaboration shows evidence for parton composition of the nucleon when E/sub nu/ greater than 2 GeV. The ratio of neutron to proton total cross sections is measured to be 1.40 +- 0.31 in this energy region. (auth)

5949 (ORO—3992-235) **Violation of unitarity in Weinberg's unified theory with bilinear gauge conditions.** Hsu, J.P.; Sudarshan, E.C.G. (Texas Univ., Austin (USA). Center for Particle Theory). Oct 1975. 27p. Dep. NTIS $5.00.

The usual formalism for non-Abelian gauge theories is not completely satisfactory. Calculations show that the usual formalism for Weinberg's unified gauge theory with a bilinear gauge condition leads to violation of unitarity, contrary to general formal proofs of unitarity. In contrast, the Lagrange multiplier formalism for this theory gives rise to unitary amplitudes; their unitarity was checked explicitly at the 1-loop and the 2-loop levels. This shows the general validity of the Lagrange multiplier formalism and its advantages over the usual formalism. (auth)

5950 (ORO—3992-237) **Spin zero exchange model of weak interactions.** Dicus, D.A.; Segre, G.C.; Teplitz, V.L. (Texas Univ., Austin (USA). Center for Particle Theory). Oct 1975. 65p. Dep. NTIS $5.50.

A renormalizable model in which weak interactions are mediated by spin-zero exchange rather than by spin-one exchange is studied. The lowest order diagrams for μ and β decay are box diagrams. Neutrino cross sections of leptons and hadrons are calculated for the effective charged and neutral currents of the model. Weak corrections to e^+e^- yields $\mu^+\mu^-$ and higher order contributions to μ decay are also calculated. Neutral current effects are predicted to be small for neutrinos on lepton targets and large for e^+e^- yields $\mu^+\mu^-$; their strength is fixed by ν-hadron scattering. In particular, there is a sizeable suppression of ν/sub μ/e scattering and a large enhancement of the asymmetry in e^+e^- yields $\mu^+\mu^-$. The only troublesome prediction is a parameter-free value of one for the ratio sigma(ν/sub μ/ + N yields ν/sub μ/ + X)/sigma(antiν/sub μ/ + N yields antiν/sub μ/ + X). On the whole, however, the model provides a sensible, renormalizable alternative to the gauge theories. (auth)

5951 Comment of the decay of psi (3.1) into even—G-parity states. Chanowitz, M.S. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., D;* **12**: No. 3, 918-922(1 Aug 1975).

We discuss what can be learned about the dynamics of the new particles by studying the decays of psi (3.1) into even—G-parity states.

STRONG INTERACTIONS, GENERAL

5952 (ANL/HEP-CP—75-52) **Diffractive processes.** Derrick, M. (Argonne National Lab., Ill. (USA)). 1975. 44p. (CONF-750858—10). Dep. NTIS $5.00.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

Recent results on elastic scattering of hadrons, single and double inelastic diffraction, and double Pomeron exchange are reviewed. Comments are made on features of the data that can be simply understood using optical models or the triple Regge model. (auth)

5953 (COO—2271-53B) **High energy hadron-nucleus scattering.** Koplik, J.; Mueller, A.H. (Columbia Univ., New York (USA). Dept. of Physics). 1975. 7p. Dep. NTIS $4.50.

Theoretical expectations for hadron-nucleus scattering at high energy if the basic hadron-hadron interaction is due to Regge poles and cuts arising in multiperipheral or soft field theory models are described. Experiments at Fermilab may provide a critical test of such models. (auth)

5954 (COO—3285—22) **Abstract algebra for physicists.** Zeman, J. (Johns Hopkins Univ., Baltimore, Md. (USA). Dept. of Physics). Jun 1975. Contract E(11-1)-3285. 25p. Dep. NTIS $4.25.

5955 Quark confinement, rising trajectories, and asymptotic behavior of form factors. Muller-Kirsten, H.J.W. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **12**: No. 4, 1103-1122(15 Aug 1975).

Several long-range force models of quark confinement are considered, with particular emphasis on gluon exchange analogous to linear and harmonic potentials. First, the nonrelativistic case is discussed, and the connection between the rise of the Regge trajectories and the power of the potential is derived. Then semirelativistic and relativistic equations are considered. It is shown that in each case the rising trajectories result from large quark—gluon coupling constants. It is also shown that an asymptotic power decrease of bound-state form factors follows only if the interaction contains an additional Coulomb- or Yukawa-type part, and only in the spacelike or the timelike domain. The significance of infrared cutoffs is examined, violations of unitarity are pointed out, and the behavior in the static limit is discussed.

5956 Pion production from a classical source: Transport and hydrodynamical properties. Cooper, F.; Sharp, D.H. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). *Phys. Rev., D;* **12**: No. 4, 1123-1131(15 Aug 1975).

We discuss how to determine the hydrodynamic and transport properties of a pion field produced in a high-energy collision. It is shown that a Boltzmann-type equation can be obtained for a relativistic generalization of the Wigner distribution function. In simple models, one can construct the expectation value of the normal-ordered energy—momentum tensor from the second moments of this distribution function. For a $\lambda\phi^4$ theory, treated in the Hartree approximation, we show that the transport equation for the pion field is similar, in the limit hyields0, to that for a single-species plasma, treated in the Vlasov approximation. We show that if pions are produced in a coherent state, the hydrodynamic properties of the field are those of an ideal fluid. In particular, pion production by a c-number source provides a realization in field theory of Landau's hydrodynamical model.

STRONG INTERACTIONS, BARYON NO. 0

5957 Coherent rho-meson photoproduction in nuclei by means of Jastrow correlated wave functions. Oset, E. (State Univ. of New York, Stony Brook). *Lett. Nuovo Cim.;* **13**: No. 9, 327-333(28 Jun 1975).

5958 (ORO—3992-234) **Spectrum generating SU(3) and SU(4) and the leptonic decay of rho, ω, phi, J/psi.** Bohm, A. (Texas Univ., Austin (USA). Center for Particle Theory). 1975. 22p. Dep. NTIS $4.25.

SU(e) and SU(4) are considered as spectrum generating groups and applied to the decays of rho yields e anti e, ω yields e anti e, phi yields e anti e, J/psi yields e anti e. The results are compared with the experimental data, which leads to predictions of the form of the electromagnetic transition operator (currents). (auth)

5959 **Hadron mass formulae in a charmed-quark model.** Lichtenberg, D.B. (Indiana Univ., Bloomington). *Lett. Nuovo Cim.*; 13: No. 9, 346-350(28 Jun 1975).

STRONG INTERACTIONS, BARYON NO. 1

5960 (ANL/HEP-CP—75-50) **Observation of f-f' interference in π^-p yields K^-K^+n at 6 GeV/c.** Pawlicki, A.J.; Ayres, D.S.; Diebold, R.; Kramer, S.L.; Wicklund, A.B. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-eng-38. 3p. (CONF-750858—1). Dep. NTIS $4.00.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

Preliminary results from a study of π^-p yields K^-K^+n at 6 GeV/c with the Argonne Effective Mass Spectrometer are presented. The 100,000-event data sample shows a dramatic drop in the Y_4^0 moment of the K^-K^+ decay angular distribution at a K^-K^+ mass of 1500 MeV. This feature is interpreted as a result of f-f' interference, which can also explain the excess of D-wave cross section near 1450 MeV observed previously. (auth)

5961 (COO—1428-424) **π^-p backward elastic scattering in the 5 GeV/c region.** Dixon, R.L.; Fletcher, J.M.; Garfinkel, A.F.; Loeffler, F.J.; Mudrak, S.; Shibata, E.I.; Stanfield, K.C.; Tang, Y.W.; Hoffman, E.W. (Argonne National Lab., Ill. (USA)). [nd]. 18p. (CONF-750729—5). Dep. NTIS $4.50.

From New directions in hadron spectroscopy meeting; Argonne, Illinois, USA (7 Jul 1975).

Preliminary results are reported for π^-p yields $p\pi^-$ differential cross sections at six beam momenta between 4.75 and 5.2 GeV/c for 0 greater than u greater than -0.7 $(GeV/c)^2$. These data are discussed in terms of the possible existence of narrow structure in the center-of-mass energy dependence as would be exhibited by an Ericson fluctuation or a narrow pion-nucleon resonance. (auth)

5962 (FERMILAB-Conf—75/79-THY) **Why are hyperons interesting and different from nonstrange baryons.** Lipkin, H.J. (Weizmann Inst. of Science, Rehovoth (Israel); Argonne National Lab., Ill. (USA); Fermi National Accelerator Lab., Batavia, Ill. (USA)). Oct 1975. 21p. (CONF-750858—13). Dep. NTIS $4.50.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

The discussion of hyperons covers the necessity of having hyperons, strangeness, charm, and all that, strangeness effects in hadron total cross sections, spin—isospin structure in hyperons, a detailed analysis of strangeness-exchange couplings, and nonleptonic tonic. (JFP)

5963 **Baryon decimet mass splittings.** Lichtenberg, D.B. (Indiana Univ., Bloomington). pp 379-391 of In Proceedings of the ninth Balaton symposium on particle physics high energy hadron interactions. Vol. I. Bloomington, IN; University of Indiana (1975).

From 9. Balaton symposium on particle physics high energy hadron interactions; Budapest, Hungary (1975).

According to the Gell-Mann-Okubo mass formula, the masses of the members of the baryon decimet should obey an equal-spacing rule. Because the Δ and Σ^* members of the decimet are broad resonances, there is a difficulty in deciding what their masses are. The experimental data and the question of interpretation are discussed. It is concluded that the present difficulty is more a problem of theoretical interpretation than of inadequate data. If the mass and width of a resonance are defined in terms of the position of the pole of the S matrix in the complex energy plane, then the equal-spacing rule is not well satisfied, but the weaker sum rule M/sub OMEGA/ - M/sub DELTA/ = 3(M/sub XI*/ - M/sub SIGMA*/ holds quite accurately. This latter sum rule follows in second-order perturbation theory from the assumption that the mass operator transforms like an SU(3) singlet-plus-octet. (auth)

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

5964 (BNL—20533) **Λ^0 inclusive production in Σ^--nucleus reactions.** Arik, E.; Cleland, W.E.; Dris, M. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 14p. (CONF-750858—5). Dep. NTIS $4.50.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

A counter spark chamber experiment was done in the AGS 23- GeV/c charged hyperon beam to study Λ^0 inclusive production in reactions of Σ^- on Al, Cu, W, and Pb. Preliminary results are reported on the missing mass spectra in the reaction $\Sigma^- +$ Nucleon yields $\Lambda^0 +$ M#/sub x/. The data are compared with the relevant triple Regge formalism. (auth)

5965 (COO—1428-429) **Study of nuclear fragment emission in proton heavy nucleus collision from 10 to 500 GeV/c.** (Fermi National Accelerator Lab., Batavia, Ill. (USA); Reaction Motors, Inc., Denville, N.J. (USA)). 16 Sep 1975. 9p. (PU—75-425). Dep. NTIS $4.50.

We propose to measure the double differential cross section of nuclear fragments (2 less than or equal to Z less than or equal to 16), for a given incident momentum, produced by proton heavy nucleus (20 less than or equal to Z less than or equal to 80) collisions in the 10 to 500 GeV/c momentum range. Recent experimental results and theoretical speculations suggest collective nuclear motion is initiated by the passage of a fast proton through a heavy nucleus. The novel feature of this experiment is the determination of the energy dependence of the excitation mechanism. Because nuclear fragments are best studied from thin targets, one needs a very high beam flux to obtain sufficient event rates. These considerations make the Internal Target Area with a heavy gas jet target the ideal place to initiate our experimental program. The detection system will consist of four conventional ΔE- E semiconductor telescopes. (auth)

5966 **Two-component model for the associated multiplicity in inclusive reactions.** Alonso, J.L.; Wright, A.C.D. (Stanford Linear Accelerator Center, Stanford Univ. California 94305). *Phys. Rev., D;* 12: No. 3, 776-784(1 Aug 1975).

A simple, two-component model for the charged multiplicity associated is presented with the observed particle in an inclusive reaction. At small p/subT/ the scattering is ascribed to a coherent or "soft" component, whereas at large p/subT/ the production mechanism is assumed to be incoherent or "hard." At fixed incident energy and missing mass, the p/subT/ dependence of n/subc/ is given by the relative weights of hard and soft scattering, so that the multiplicity is a sensitive probe of the transition region between the two components. The model is applied to recent multiplicity data for pp yields pX and pp yields π^+X at 28.5 GeV/c, as well as to data at Fermilab and CERN-ISR energies.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

5967 **Determination of the relativistic wave equations associated with a give representation of S L (2,C).** Hurley, W.J.; Sudarshan, E.C.G. (Univ. of Texas, Austin). *J. Math. Phys. (N.Y.);* 16: No. 10, 2093-2098(Oct 1975).

Straightforward algebraic techniques are presented and used to determine the structure of wave equations whose relativistic covariance is governed by two representations of SL(2,C), $S_0(\Lambda) = (1,1/2) + (1/2,1) + (1/2,0) + (0,1/2)$ and $S_1(\Lambda) = S_0(\Lambda) + (1/2,0) + (0,1/2)$, subject to the requirements that the equations should be parity preserving, admit an invariant Hermitian bilinear form realized by a numerical matrix eta, and that they should describe a particle with a unique mass and spin. It is shown that $S_0(\Lambda)$ leads to a unique algebraic structure, that of the Rarita—Schwinger equation, whereas $S_1(\Lambda)$ leads either to a trivial extension of the former case or to a family of equations whose matrices have a minimal algebra with degree one higher than that of the former case. One such example reproduces the equation presented by Glass. When, contrary to custom, a singular eta matrix is considered, it is shown that $S_1(\Lambda)$ allows for equations whose coefficient matrices are reducible but indecomposable. These equations are completely equivalent to the Rarita—Schwinger equation in the free case, but the added components may enter the dynamics in the presence of certain interactions. The present examples serve to illustrate techniques which may be applied in the study of any relativistic wave equation. (auth)

APPLICATIONS TO STRONG INTERACTIONS

5968 (LA-UR—75-2050) **Parity violating asymmetry in the radiative capture of polarized neutrons by protons.** Craver, B.A.; Kim, Y.E.; Tubis, A.; Herczeg, P.; Singer, P. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 4p. (CONF-760101—1). Dep. NTIS $4.50.

From International conference on few body problems in nuclear and particle physics; Delhi, India (29 Dec 1975).

A parity violating effect of interest in the n + p yields d + γ reaction is the asymmetry α in the photon angular distribution with respect to an initial neutron polarization. Calculations of α, using a two-nucleon Reid soft core potential, are reported. The calculations, exact with respect to the strong interaction, are facilitated by Green's function techniques. (6 figures, 2 tables) (SDF)

FIELD THEORY

5969 (CONF-750975—3) **Problems of quantum electrodynamics in heavy-ion collisions.** Mueller, B. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 15p. Dep. NTIS $4.50.

From 4. international conference on beam-foil spectroscopy; Gatlinburg, Tennessee, USA (15 Sep 1975).

The use of heavy ion reactions in studying basic problems of very strongly bound particles is discussed. Specifically, the fusion of two heavy nuclei, e.g., u + u, to form a superheavy quasimolecule is considered theoretically, with suggestions given for possible experiments. (12 figures) (SDF)

5970 (COO—2271-62) **Quantum expansion of soliton solutions.** Christ, N.H. (Columbia Univ., New York (USA)). 1975. 12p. (CONF-750695—2). Dep. NTIS $4.50.

From Conference on extended systems in field theory; Paris, France (26 Jun 1975).

A method for giving quantum mechanical meaning to particle-like (soliton) classical solutions is described in an attempt to relate particle-like solutions of classical nonlinear field theory to physical hadrons. The method uses the familiar canonical Hilbert space formalism of quantum mechanics and has been applied to the quantum mechanical interpretation of both static and time-dependent classical soliton solutions. (SDF)

5971 (ORO—3992-227) **Symmetry and exact dyon solutions for classical Yang—Mills field equations.** Hsu, J.P.; Mac, E. (Texas Univ., Austin (USA). Center for Particle Theory). Aug 1975. 18p. Dep. NTIS $4.00.

It is shown that the conserved magnetic and electric charges in non-Abelian theories have nothing to do with the Higgs scalars and/or the symmetry structure of the Lagrangian. They are a consequence of the local isospin gauge symmetry. Several exact static dyon solutions to the nonlinear classical field equations are presented in both massless and massive Yang-Mills theories, which possess both electric and magnetic charges. (auth)

5972 **Quark bags and local field theory. II. Confinement of Fermi and vector fields.** Creutz, M.; Soh, K.S. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **12**: No. 2, 443-447(15 Jul 1975).

We extend earlier work on obtaining the "bag" model of Chodos, Jaffe, Johnson, Thorn, and Weisskopf as a limit of a local field theory. As before, the discussion is on a classical level. We show how to confine Fermi and vector fields into the bag solutions found previously. In an appropriate limit we obtain exactly the Chodos et al. model for confinement of all fields except non-Abelian gauge fields. For the latter fields we argue that it is impossible from a local theory to obtain the same boundary conditions used in the Chodos et al. model. The boundary conditions we find do not have the virtue of completely eliminating "color" nonsinglet states from the theory. We propose an alternative scheme based on a single triplet of quarks and an Abelian gauge field. The baryons are bound states of three quarks and one additional scalar constituent.

5973 **1/N expansion as a loop expansion.** Root, R.G. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **12**: No. 2, 448-457(15 Jul 1975).

The 1/N expansion of the effective action of the O(N) model is formulated as a loop expansion. Three variations of the expansion are given: one which requires the fewest graphs for a given order, one in which the power of 1/N coincides with the number of loops, and one which does not involve mixed propagators and which is easily a$_{\rho\rho}$plied to the study of the complete effective action.

5974 **Trace and Ward-Takahashi identity anomalies in an SU(3) current model with energy-momentum tensor.** Zacrep, D.B.; Young, B. (Ames Laboratory-ERDA and Department of Physics, Iowa State University, Ames, Iowa 50010). *Phys. Rev., D;* **12**: No. 2, 513-522(15 Jul 1975).

We discuss the validity of the naive Ward-Takahashi identities and trace identities for arbitrary n-point functions (n-pf's) of scalar, pseudoscalar, vector, and axial-vector currents and the improved energy-momentum tensor, thus extending the previous investigations in a unified way. We show that the validity of the naive Ward-Takahashi identities of the energy-momentum tensor implies the satisfaction of those of the vector currents. This removes an ambiguity concerning the minimal sets of anomalous current Ward-Takahashi identities. We find that all the anomalous Ward-Takahashi identities for the broad structure of n-pf's are again restricted to the axial-vector current of n-pf's of abnormal parity in a well-defined pattern, and the trace identity anomalies occur only in normal-parity n-pf's. We give all these anomalies. Our results show that there are no new anomalies associated with the inclusion of the energy-momentum tensor in the n-pf's.

5975 **Effective potential of a non-Abelian supersymmetric theory.** Woo, G. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **12**: No. 4, 975-978(15 Aug 1975).

The effective potential of a non-Abelian supersymmetric theory with internal isospin symmetry is considered. In the one-loop approximation it is shown that the potential is finite without renormalization, and that where it is not zero, it is complex. In two loops, as in one loop, it is shown that the effective potential of the scalar fields alone vanishes identically. Implications of these results are discussed with reference to possible spontaneous symmetry breaking.

5976 **Quantum fluctuations in a phi^4 field theory: I. Stability of the vacuum.** Chang, S. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510 and Department of Physics, University of Illinois, Urbana, Illinois 61801). *Phys. Rev., D;* **12**: No. 4, 1071-1088(15 Aug 1975).

We study the effect of quantum fluctuations in a phi^4 field theory using a Hartree-type approximation. We reduce the operator field equations into a set of coupled c-number (infinite in number) equations. We show that these equations can also be derived from a variational principle. We carry out the renormalization procedure in the one-dimensional theory in detail and demonstrate how the renormalization can be done in a fashion consistent with the Hartree approximation. We then apply the technique to study the effective potential and the stability of the vacuum. We find that the abnormal vacuum is unstable as the coupling becomes strong, and a transition between the abnormal (<phi>not equal to) and the normal (<phi>=0) vacua occurs in both the one- and the three-dimensional theory. A generalization of the theory to include internal symmetries is briefly outlined.

5977 **Fermions in Yang—Mills potentials.** Swank, J.H.; Swank, L.J.; Dereli, T. (Department of Physics, Yale University, New Haven, Connecticut 06520). *Phys. Rev., D;* **12**: No. 4, 1096-1102(15 Aug 1975).

It is shown that the magnetic monopole of 't Hooft and an isospinor fermion do not have any bound states. Further, the dyon of Julia and Zee considered as a fixed field configuration does not bind an isospinor fermion. An example is given of an infinite-energy solution of the pure Yang—Mills theory which, when taken as a potential in a wave equation, will confine the wave function.

5978 **Short-distance behavior of the Bethe—Salpeter wave function in the ladder approximation.** Guth, A.H.; Soper, D.E. (Department of Physics, Columbia University, New York, New York 10027). *Phys. Rev., D;* **12**: No. 4, 1143-1164(15 Aug 1975).

We investigate the short-distance behavior of the (Wick-rotated) Bethe—Salpeter wave function for the two spin-1/2 quarks bound by the exchange of a massive vector meson. We use the ladder-model kernel, which has the same p^{-4} scaling behavior as the true kernel in a theory with a fixed point of the renormalization group at g not equal to 0. For a bound state with the quantum numbers of the pion, the leading asymptotic behavior is chi (q/sup μ/) ~ cq/sup -4 + epsilon(g)/γ_5, where ϵ (g) =1- (1-g^2/π^2)$^{1/2}$. Our method also provides the full asymptotic series, although it should be noted that the nonleading terms will depend on the nonleading behavior of the ladder-model kernel. A general term has the form cq^{-}/sup a/(lnq)/sup n/phi (q/sup μ/), where c is an unknown constant, a may be integral or nonintegral, n is an integer, and phi (q/sup μ/) is a representation function of the rotation group in four dimensions.

5979 **Comments on "Bose condensation in supercritical external fields".** Klein, A.; Rafelski, J. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). *Phys. Rev., D;* **12**: No. 4, 1194-1195(15 Aug 1975).

We agree that our previous analysis does not apply to a spinless particle in an external Coulomb field. We explain why it continues to apply in toto for a spinless particle in a short-range external field. We describe in qualitative terms the correct quantization for the Coulomb case, which has not previously appeared in the literature.

5980 **Two-particle collision in aesthetic field theory.** Muraskin, M.; Ring, B. (Stanford Univ., CA). *Found. Phys.;* **5**: No. 3, 513-523(Sep 1975).

A new computer solution was found to the aesthetic field equations. This solution describes a two-particle system with more structure than previously found. The contour lines show an arm structure. Four arms were observed around the maximum center.

The location of the maximum (minimum) center is not along a straight line as a function of time. This is the first time that such an effect was observed for any kind of nonlinear partial differential equation, so far as is known. A further discussion of the aesthetic principles leading to the field equations is given. (auth)

SCATTERING THEORY

5981 (BNL—20353) **Linear, functional equation approach to the problem of the convergence of pade approximants.** Baker, G.A. Jr. (Brookhaven National Lab., Upton, N.Y. (USA)). 6 Aug 1975. 14p. (CONF-750575—1). Dep. NTIS $4.00.

From Euromech 58 conference on pade method and its applicatons in mechanics; Toulon, France (12 May 1975).

The Pade approximant problem is related to a (not necessarily orthogonal) projection of a linear functional equation of the Fredholm type. If the kernel is of trace class and its upper Hessenberg form is tridiagonal (this class includes Hermitian operators), then it is proven that not only do the diagonal Pade approximants converge, but so do their numerators and denominators separately. The generalization of these results to C/sub p/ classes of compact operators is given. For kernels which are not only compact, but also satisfy an additional mild restriction, a pointwise convergence theorem is proven. The application of these results to quantum scattering theory is indicated. (auth)

NUCLEAR PHYSICS

5982 (CONF-750303—77) **Radioactive-nuclide decay data in science and technology.** Reich, C.W.; Helmer, R.G. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. 7p. Dep. NTIS $4.50.

From Proceedings on nuclear cross section and technique; Washington, District of Columbia, USA (3 Mar 1975).

The scope of ENDF/B has recently been expanded to include radioactive-nuclide decay data. In this paper, the content and organization of the decay data which are included in ENDF/B are presented and discussed. The application of decay data in a wide variety of nuclear-related activities is illustrated by a number of examples. Two items pointed up by the ENDF/B decay-data compilation effort are treated: the identification of deficiencies in the data; and the importance of a radioactive-nuclide metrology effort oriented toward supplying these needs in a systematic fashion. (3 figures, 1 table) (auth)

5983 (CONF-751101—20) **One more algorithm for generating elastic and inelastic scattering matrices.** Grimesey, R.A. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 3p. Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Much effort in recent years has been spent on attempts to optimize the numerical problem of calculating elastic and inelastic multigroup scattering matrices from basic ENDF/B data. This paper presents an algorithm which minimizes the amount of data manipulation and approximation required. The algorithm is based on avoiding time-consuming transformations between c.m. and lab coordinates for the differential cross section and the additional requirement with the ETOG algorithm to manufacture Legendre expansion coefficients if tabular distributions are given. The new algorithm was incorporated into the ETOP code, which generates elastic and inelastic scattering matrices for the 68-group Phrog II fast spectrum code. CPU time is roughly a factor of 4 faster than the ETOG algorithm in the most favorable cases for ETOG. (RWR)

5984 (LBL—4000) **Nuclear chemistry. Annual report, 1974.** Conzett, H.E.; Edelstein, N.M.; Tsang, C.F. (eds.). (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. Contract W-7405-eng-48. 434p. Dep. NTIS $10.60.

The 1974 Nuclear Chemistry Annual Report contains information on research in the following areas: nuclear science (nuclear spectroscopy and radioactivity, nuclear reactions and scattering, nuclear theory); chemical and atomic physics (heavy ion-induced atomic reactions, atomic and molecular spectroscopy, photoelectron spectroscopy and hyperfine interactions); physical, inorganic, and analytical chemistry (x-ray crystallography, physical and inorganic chemistry, geochemistry); and instrumentation. Thesis abstracts, 1974 publication titles, and an author index are also included. Papers having a significant amount of information are listed separately by title. (RWR)

NEUTRON INTERACTIONS WITH MATTER

5985 (ANL/NDM—17) **Sample-size effects in fast-neutron gamma-ray production measurements: solid-cylinder samples.** Smith, D.L. (Argonne National Lab., Ill. (USA)). Sep 1975. Contract W-31-109-eng-38. 64p. Dep. NTIS $5.50.

The effects of geometry, absorption and multiple scattering in (n,Xγ) reaction measurements with solid-cylinder samples are investigated. Both analytical and Monte-Carlo methods are employed in the analysis. Geometric effects are shown to be relatively insignificant except in definition of the scattering angles. However, absorption and multiple-scattering effects are quite important; accurate microscopic differential cross sections can be extracted from experimental data only after a careful determination of corrections for these processes. The results of measurements performed using several natural iron samples (covering a wide range of sizes) confirm validity of the correction procedures described herein. It is concluded that these procedures are reliable whenever sufficiently accurate neutron and photon cross section and angular distribution information is available for the analysis. (13 figures, 5 tables) (auth)

5986 (CINDA—75(Vol.1)) **Index to the literature on microscopic neutron data. Volume 1. Z less than or equal to 52.** (International Atomic Energy Agency, Vienna (Austria)). 1 Apr 1975. 1033p. IAEA (2 vols. and a suppl. $58.00).

5987 (CINDA—75(Vol.2)) **Index to the literature on microscopic neutron data. Volume 2. Z greater than or equal to 53.** (International Atomic Energy Agency, Vienna (Austria)). 1 Apr 1975. 987p. IAEA (2 vols. and a suppl. $58.00).

5988 (IS-M—54) **Magnetic scattering of neutrons by a relativistic atom in the l/sup N/ configuration.** Stassis, C.; Deckman, H.W. (Iowa State Univ. of Science and Technology, Ames (USA). Dept. of Physics). 1975. 12p. (CONF-751209—11). Dep. NTIS $4.50.

From 21. annual conference on magnetism and magnetic materials; Philadelphia, Pennsylvania, USA (9 Dec 1975).

The magnetic scattering of neutrons by an atom described by a relativistic Hamiltonian was examined. It is shown that the magnetic scattering amplitude can be expressed in terms of (relativistic) matrix elements of relativistic magnetic and electric multipole operators. An effective magnetic scattering amplitude is then defined so that a relativistic result is obtained by taking matrix elements of this operator between non-relativistic states of the atom. Quite generally the effective magnetic scattering amplitude can be expressed in terms of relativistic radial integrals and the Racah tensors W/sup (O,k)k/ and W/sup (l,k')k/ ($k' = k, k+-1$). For simplicity, explicit expressions for the relativistic radial integrals are given for the experimentally important case of neutron scattering by an atom in the l/sup N/ configuration. (auth)

5989 (LA—6145-MS) **Coarse-mesh rebalance methods compatible with the spherical harmonic fictitious source in neutron transport calculations.** Miller, W.F. Jr. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-Eng-36. 16p. Dep. NTIS $4.00.

The coarse-mesh rebalance method, based on neutron conservation, is used in discrete ordinates neutron transport codes to accelerate convergence of the within-group scattering source. Though very powerful for this application, the method is ineffective in accelerating the iteration on the discrete-ordinates-to-spherical-harmonics fictitious sources used for ray-effect elimination. This is largely because this source makes a minimum contribution to the neutron balance equation. The traditional rebalance approach is derived in a variational framework and compared with new rebalance approaches tailored to be compatible with the fictitious source. The new approaches are compared numerically to determine their relative advantages. It is concluded that there is little incentive to use the new methods. (3 tables, 5 figures) (auth)

5990 (ORNL-TM—4660) **16 and 123 group weighting functions for KENO.** Knight, J.R.; Petrie, L.M. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-Eng-26. 73p. Dep. NTIS $5.45.

Weighting functions for use in the KENO Monte Carlo criticality program have been prepared. Discrete ordinate neutron transport calculations provided adjoint fluxes in reflector materials commonly encountered in KENO calculations. 16 and 123 group weights for water, paraffin, concrete, and graphite were computed by the adjoint biasing method. The results of these calculations are presented in the form of tables and graphs. The use of these weights in various applications has significantly reduced the number of neutron histories required to obtain a given variance in the k/sub eff/ computed by KENO. (8 tables, 9 figures) (auth)

5991 (ORNL-TM—5020) **One-dimensional fast-neutron transport benchmark calculations.** Ching, J.; Oblow, E.M. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 95p. Dep. NTIS $5.45.

A series of state-of-the-art fast-neutron transport calculations were made for several simple shield materials of interest to the Defense Nuclear Agency. The calculations should serve as benchmarks for testing newly evaluated neutron cross-section data and multigroup libraries. Results are presented for one-dimensional spherical systems of iron, air, and concrete (SiO_2). The results include detailed flux spectra, broad-group fluxes versus distance, and convergence tests for representations of the P/sub l/ scattering kernel and for space, angle, and energy grids. The methods employed in converging the solutions differ from previous benchmark calculations in that sensitivity and point-energy techniques were used to determine the energy grid for the final results. (auth)

5992 (ORNL-TM—5072) **Measurement of secondary neutrons and gamma rays produced by neutron interactions in aluminum over the incident energy range 1 to 20 MeV.** Morgan, G.L. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-Eng-26. 34p. Dep. NTIS $4.00.

The spectra of secondary neutrons and gamma rays produced by neutron interaction in a thin sample (approximately 1/6 mean free path) of aluminum have been measured as a function of the incident neutron energy over the range 1 to 20 MeV. Data were taken at an angle of 125°. A linac (ORELA) was used as a neutron source with a 47-m flight path. Incident energy was determined by time-of-flight, while secondary spectra were determined by pulse-height unfolding techniques. The results of the measurements are presented in forms suitable for comparison to calculations based on the evaluated data files. (6 tables, 4 figures) (auth)

5993 (ORNL-tr—4020) **Optimization of a storage variant of equipment for measuring the storage variant of the electrical dipole moment of a neutron using ultracold neutrons.** Taran, Yu.V. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1974. Translation by M. Gerrard of JINR—BI-13-8441. 9p. Dep. NTIS $4.50.

A regime of operation of equipment for measuring the electrical dipole moment (EDM) of a neutron using ultracold neutrons in a storage variant is considered. Two methods of optimizing the equipment are discussed: one based on minimization of the EDM measurement error and the error of a pair of adjacent measurements with different relative orientations of the magnetic and electric fields (cycle error). The practical equivalence of the two approaches is shown for actual situations. (5 figures) (auth)

5994 (ORNL-tr—4019(Draft)) **Fast adiabatic neutron spin flip.** Taran, Yu.V. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. Translation by M. Gerrard of JINR—P3-8577. 10p. Dep. NTIS $4.50.

Some possible applications of the fast adiabatic spin flip in neutron physics are considered. The equation of the neutron spin motion in a static magnetic field with the constant gradient in the presence of an oscillating field has been solved by numerical methods. A quantitative figure of merit for the parameters of these fields for the effective neutron spin reverse is obtained by the method of adiabatic passage through resonance. (3 figures) (auth)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

5995 **Momentum-cutoff sensitivity in Faddeev calculations of trinucleon properties.** Brandenburg, R.A.; Kim, Y.E.; Tubis, A. (Institute of Theoretical Physics, University of Hannover, Hannover, Germany). *Phys. Rev., C;* 12: No. 4, 1368-1370(Oct 1975).

By increasing the cutoff q from 1.7 fm^{-1} to a value greater than or approximately equal to 2.8 fm^{-1} in momentum-space Faddeev calculations, we eliminate serveral discrepancies previously existing between momentum- and coordinate-space Faddeev calculations of trinucleon properties.

NUCLEAR REACTIONS AND SCATTERING

5996 (LA-UR—75-1447) **R-matrix analysis.** Dodder, D.C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-eng-36. 7p. (CONF-750829—7). Dep. NTIS $4.00.

From 4. international symposium on polarization phenomena in nuclear reactions; Zurich, Switzerland (25 Aug 1975).

Scattering and reaction processes involving very few nucleons are studied via the R matrix formalism of Wigner and Eisenbud. As examples, the d + ^{3}He, p + ^{4}He, ^{3}He + ^{4}He, and p + ^{6}Li are considered. (3 figures) (SDF)

5997 **Resonating-group calculation of n+^{3}H scattering.** LeMere, M.; Brown, R.E.; Tang, Y.C.; Thompson, D.R. (School of Physics, University of Minnesota, Minneapolis, Minnesota 55455). *Phys. Rev., C;* 12: No. 4, 1140-1145(Oct 1975).

The single-channel resonating-group method with a central nucleon—nucleon potential is used to study the n+^{3}H system up to a c.m. energy of about 17 MeV. The specific distortion of the triton in this system is investigated, and it is found that its effect on the n+^{3}H phase shifts is small. A phenomenological imaginary potential is included in the calculation in order to account approximately for the effects of reactions on the elastic channel. The strength of this potential is chosen to reproduce measured total reaction cross sections for the charge-conjugate system p+^{3}He. The results of the calculation are in satisfactory agreement with measured n+^{3}H elastic differential cross sections.

5998 **Optical-model analysis of N+C and C+C elastic scattering.** Eck, J.S.; Johnson, J.H.; Elliott, D.O.; Thompson, W.J. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). *Phys. Rev. Lett.;* 35: No. 14, 973-976(6 Oct 1975).

Additional data and optical-model calculations for ^{14}N+^{12}C elastic scattering which expand and fortify the recently published optical-model analysis of N+C and C+C elastic scattering by Delic are discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

5999 (CONF-750827—1) **Neutron scattering study of liquid ^{3}He.** Skold, K.; Pelizzari, C.; Kleb, B.; Ostroski, G.; Rowe, J.M. (Argonne National Lab., Ill. (USA)). Aug 1975. 8p. Dep. NTIS $4.00.

From Conference on decontamination and decommissioning of ERDA facilities; Idaho Falls, Idaho, USA (19 Aug 1975).

A study of thermal excitations in liquid ^{3}He via the inelastic scattering of neutrons is reported. Preliminary results clearly indicate that reliable scattering functions can be obtained. (3 figures) (SDF)

6000 (LA—6041-T) **Proton—proton analyzing power measurements at 16 MeV.** Lovoi, P.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Jul 1975. Contract W-7405-eng-36. 100p. Dep. NTIS $5.45.

Thesis.

Few attempts have been made to measure accurately the proton-proton analyzing powers at low energies. With the advent of polarized particle beams the measurement can now be made with high accuracy. Analyzing powers were measured at nine scattering angles from 10° to 35° in the laboratory system. As a check on systematic errors, analyzing power measurements were also made by scattering protons from ^{4}He. In the p Vector-p case the measured values are in very good agreement with the phase shift predictions. The p Vector-^{4}He measurements, while giving the same form and sign as the phase shift predictions, differ from the predictions by as much as 11 standard deviations. The p Vector-p analyzing powers had a maximum value of -0.0043 +- 0.0004 at 10° (laboratory) and decreased to zero near 25°. A new technique to measure analyzing powers without symmetric detectors is explained. This technique preserves the advantages of the symmetric arm method in that current integration, target density, detector efficiencies, and geometry are cancelled from the final expressions. A new scattering chamber, named the Supercube, is described. The Supercube was designed primarily to perform scattering experiments with a polarized beam. It contains both left-right and up-down detectors for use with both spin-1/2 and spin-1 measurements. The Supercube was designed to make analyzing power measurements to an accuracy of 0.001 routine. The Supercube has proved to have low systematic errors and to perform as expected. The systematic errors were found to be equal to or less than 0.0002. (23 figures, 14 tables) (auth)

6001 (LA-UR—75-1416) **Deuteron D-state from three body studies.** Gibbs, W.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-eng-36. 13p. (CONF-750829—6). Dep. NTIS $4.00.

From 4. international symposium on polarization phenomena in nuclear reactions; Zurich, Switzerland (25 Aug 1975).

A brief history of the deuteron wave function is given to provide a background for a discussion of recent developments in

knowledge of the deuteron D state. Techniques for measuring the percent D state in nucleon interactions with deuterium are described along with the motivation for attempting such measurements. (10 figures, 41 references) (SDF)

6002 Comments on the observations of two-photon decay in n-p capture. Alburger, D.E. (Centre de Recherches Nucleaires et Universite Louis Pasteur, Strasbourg, France). *Phys. Rev. Lett.*; **35**: No. 12, 813-815(22 Sep 1975).

Two-photon decay in n-p capture has been reported as having a branching ratio of 10^{-3} relative to single 2.23-MeV γ-ray emission. It is suggested that this result can be explained by crosstalk effects between detectors due to single γ rays, principally that associated with annihiliation in flight following pair production. The shape of the observed γ-γ coincidence spectrum is consistent with this type of crosstalk and the apparent two-photon branch is about what is expected from a rough calculation of the magnitude of the crosstalk effect.

6003 Measurement of the ^{2}H(p,n) pp transverse polarization transfer coefficient at 20.4 MeV. Graves, R.G.; Jain, M.; Knox, H.D.; Chamberlin, E.P.; Northcliffe, L.C. (Cyclotron Institute, Texas AandM University, College Station, Texas 77843). *Phys. Rev. Lett.*; **35**: No. 14, 917-920(6 Oct 1975).

The transverse polarization transfer coefficient, K/suby//suby/', has been measured for the reaction ^{2}H(p,n) pp at 18degree for E/subp/=20.4 MeV as a function of neutron energy. Although predictions based on a three-body separable-potential model with S-wave N-N interactions are in reasonable agreement with the data, the need for a three-body theory with more realistic N-N forces is indicated.

6004 α+α reaction and the origin of ^{7}Li. King, C.H.; Rossner, H.H.; Austin, S.M.; Chein, W.S.; Mathews, G.J.; Viola, V.E. Jr.; Clark, R.G. (Cyclotron Laboratory and Physics Department, Michigan State University, East Lansing, Michigan 48824). *Phys. Rev. Lett.*; **35**: No. 15, 988-991(13 Oct 1975).

Cross sections are presented for the production of ^{7}Li and ^{7}Be in the α+α reaction between threshold and 140 MeV. Implications of these measurements for the problem of the origin of ^{7}Li in the universe are discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

6005 (RLO—1388-293) **Spin assignment of J/sup π/ = 12^+ for the ^{12}C + ^{12}C resonance at E/sub 12C/ (c.m.) = 18.5 MeV.** Bernhardt, K.G.; Eberhard, K.A.; Weidinger, A. (Washington Univ., Seattle (USA). Nuclear Physics Lab.; Muenchen Univ. (F.R. Germany). Sektion Physik). 1975. 2p. Dep. NTIS $4.50.

In an effort to obtain a more precise picture of the recently observed resonances in ^{12}C(^{12}C,α)^{20}Ne, ^{10}B(^{14}N,α)^{20}Ne, and ^{12}C(^{12}C,Be)^{16}O excitation functions between energies of 30 to 40 MeV in the corresponding compound nucleus ^{24}Mg, angular distributions in this energy range for the ^{12}C(^{12}C,^{8}Be)^{16}O reaction have been measured. The particle unstable ^{8}Be nucleus was identified through the coincident detection of the two α-particles by which it decays. The most prominent resonance observed in the ^{12}C(^{12}C,)^{20}Ne and (^{12}C,^{8}Be)^{16}O excitation functions occurs at E/sub ^{12}C/(c.m.) = 18.5 MeV. Angular distributions measured on and off resonance are reported, and a unique spin assignment of J/sup π/ = 12^+ for this resonance is made. (auth)

6006 (RLO—1388-295) **Mirror gamma decays in ^{13}C and ^{13}N.** Marrs, R.E.; Adelberger, E.G.; Snover, K.A.; Cooper, M.D. (Washington Univ., Seattle (USA). Dept. of Physics). 1975. 13p. Dep. NTIS $4.50.

The γ-ray branching ratios of the lowest T = $^3/_2$ levels in ^{13}C and ^{13}N, and the absolute strength of the γ_0 transition in ^{13}N have been measured. The mirror electromagnetic selection rule is obeyed by the M1 (γ_0 and γ_3) transitions. However the E1 (γ_1) transitions exhibit a surprisingly large charge asymmetry. Charge dependent differences in the radial wave functions do not account for a similar asymmetry in strong T = $^1/_2$ yields T = $^1/_2$ E1 transitions in mass-13. (2 figures, 1 table) (auth)

6007 Measurement of the energy of the 6129-keV γ ray of ^{16}O. Shera, E.B. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **12**: No. 3, 1003-1005(Sep 1975).

The precise isotopic mass-difference values of Smith and Wapstra have been used as a reference in the determination of the energy of the 6129-keV γ ray of ^{16}O. This transition is widely used as an energy standard in nuclear spectroscopy and in muonic x-ray studies. The value of the γ-ray energy was found to be 6129.170plus-or-minus0.043 keV. The quoted uncertainty is approximately one order of magnitude smaller than that of previous determinations. Data from the measurements also indicate that the new and highly precise mass values form a self-consistent set.

NUCLEAR REACTIONS AND SCATTERING

6008 (COO—3244-48) **Studies of low energy π elastic scattering from light nuclei.** Eisenstein, R.A. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). 1975. 18p. (CONF-7506100—1). Dep. NTIS $4.50.

From Proceedings of the advanced study institute in nuclear and particle physics at intermediate energies; Victoria, B.C., Canada (Jun 1975).

The elastic scattering of π^+ from ^{12}C has been investigated at 50 MeV. The angular distribution is compared with theoretical predictions using free π-N phase shifts in three potentials: the Kisslinger potential, the local Laplacian potential, and a separable potential. It is concluded that simple K and LL models are inadequate for a description of π elastic scattering at low energy. (2 tables, 7 figures) (SDF)

6009 (RLO—1388-290) **Observation of resonances in ^{24}Mg at 32-40 MeV excitation energy via the ^{12}C(^{12}C,^{8}Be)^{16}O reaction.** Eberhard, K.A.; Mathiak, E.; Stettmeier, J.; Trombik, W.; Weidinger, A.; Wuestefeld, L.N.; Bernhardt, K.G. (Muenchen Univ. (F.R. Germany). Sektion Physik; Washington Univ., Seattle (USA). Nuclear Physics Lab.). 1975. 10p. Dep. NTIS $4.50.

Strongly correlated resonances are observed in ^{12}C(^{12}C, ^{8}Be)^{16}O excitation functions at E/sub x/ = 32.6 and 39.6 MeV to various excited states in ^{16}O. At these energies correlated structures are also present in ^{12}C(^{12}C,α)^{20}Ne and ^{10}B(^{14}N,α)^{20}Ne excitation functions as reported by other workers in recent months. (auth)

6010 (RLO—1388-291) **One-neutron and two-neutron transfer in the scattering.** Reisdorf, W.N.; Lau, P.H.; Vandenbosch, R. (Washington Univ., Seattle (USA). Nuclear Physics Lab.). 1975. 45p. Dep. NTIS $5.00.

Angular distributions have been measured for one- and two-neutron transfer reactions induced by ^{18}O beams on ^{16}O targets at laboratory bombarding energies of 42 and 52 MeV. The reactions populating the ground and first excited states of ^{17}O and ^{18}O are analyzed in terms of single step finite range plus recoil DWBA theory taking into account antisymmetrization effects. Special attention is paid to an internally consistent description of the observed absolute magnitudes of all the reactions and to the theoretically expected interferences between various backward-forward scattering mechanisms. The importance of neutron transfer in accounting for different absorbing properties of the ^{16}O-^{18}O systems as compared to the ^{16}O-^{16}O system is shown. (13 figures, 2 tables) (auth)

6011 Excitation of giant magnetic and spin-isospin dipole states in radiative π capture on ^{14}N and ^{10}B. Baer, H.W.; Bistirlich, J.A.; de Botton, N.; Cooper, S.; Crowe, K.M.; Truol, P.; Vergados, J.D. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., C;* **12**: No. 3, 921-937(Sep 1975).

The photon spectra in the capture of stopped pions on ^{14}N and ^{10}B were measured in the 50—150 MeV region with a high-resolution pair spectrometer. The total radiative capture branching ratios are 2.13 plus-or-minus 0.21 and 2.27 plus-or-minus 0.22%, respectively. The spectrum corresponding to the first 13 MeV excitation in each of the residual nuclei ^{14}C and ^{10}Be is dominated by the transition to the analog of a giant M1 state of the target nucleus. The ground state transitions in both nuclei are resolved experimentally. The measured branching ratio for the extremely weak ^{14}C(g.s.) transition is (3 plus-or-minus 2) times10^{-5}. There is evidence for selective excitation of the analogs of the giant diople spin-isospin states of ^{14}N, of which the 3^- component appears to be the strongest. In ^{10}B the transition strength to the giant resonance region is more fragmented. An analysis is presented that employs an impulse-approximation Hamiltonian with amplitudes taken directly from the fundamental process on the nucleon, π^-+p yields n+γ, and shell-model wave functions obtained using realistic interactions in the 1s, 1p, and 2s-1d shells. Also, a calculation for the ^{14}C(g.s.) transition from 1s capture using the ''elementary-particle soft-pion'' ansatz is presented.

6012 Structure in the energy dependence of the proton total reaction cross section for C and Si in the energy region 20—40 MeV. Slaus, I.; Margaziotis, D.J.; Carlson, R.F.; van Oers, W.T.H.; Richardson, J.R. (Institute Ruder Boskovic, Zagreb, Yugoslavia). *Phys. Rev., C;* **12**: No. 3, 1093-1095(Sep 1975).

Measurements of proton total reaction cross sections for ^{9}Be, ^{12}C, ^{16}O, and ^{28}Si have been made in the energy range between 20—44 MeV. The cross sections show irregular energy variation for ^{12}C at about 23.8 and 25.9 MeV, and for ^{28}Si at 30.3 and 33.5 MeV; irregularities were not observed clearly for ^{9}Be or ^{16}O.

6013 Confirmation of the predicted L dependence in the radial form factor for nucleus-nucleus inelastic scattering. Moffa, P.J.; Vary, J.P.; Dover, C.B.; Towsley, C.W.; Hanus, R.G.; Nagatani, K. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.*; 35: No. 15, 992-995(13 Oct 1975).

The multipolarity (L) dependence of the inelastic form factor for heavy-ion-induced excitations predicted by the folding model is confirmed in the analysis of the scattering of ^{14}N from ^{12}C and ^{16}O at 155 MeV. Agreement between the target deformation lengths (β/subL/R/subt/) of these measurements and those from electromagnetic and proton experiments is found when the strongly L-dependent folding-model form factor is employed.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

6014 (ORNL-TM—5081) **Gamma-ray production due to neutron interactions with silver for incident neutron energies between 0.3 and 20 MeV: tabulated differential cross sections.** Dickens, J.K.; Love, T.A.; Morgan, G.L. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-Eng-26. 63p. Dep. NTIS $5.45.

Numerical values of differential cross sections for gamma rays produced by neutron reactions with silver have been obtained for neutron energies between 0.3 and 20 MeV for theta/sub gamma/ = 125°. The d²sigma/dωdE values were obtained using a NaI spectrometer. These data are presented as gamma-ray production group cross-section values of d²sigma/dωdE for 0.3 less than or equal to E/sub gamma/ less than or equal to 10.5 MeV, with gamma-ray intervals ranging from 15 keV for E/sub gamma/ less than or equal to 0.4 MeV to 160 keV for E/sub gamma/ approximately 9 MeV. Neutron energy intervals varied from 0.10 MeV for E/sub n/ between 0.3 and 0.4 MeV to 3 MeV for E/sub n/ between 14 and 20 MeV. (auth)

6015 Kilovolt ^{33}S(n,α_0) and ^{33}S(n,γ) cross sections: Importance in the nucleosynthesis of the rare nucleus ^{36}S. Auchampaugh, G.F.; Halperin, J.; Macklin, R.L.; Howard, W.M. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). *Phys. Rev., C;* 12: No. 4, 1126-1133(Oct 1975).

The ^{33}S(n,α_0) and ^{33}S(n,γ) cross sections have been measured from approximately 10 to approximately 700 keV. Resonance parameters are given for 39 resonances. The level spacing is determined to be 9.1 +- 0.9 keV. The σ (n,α_0) and σ (n,γ) cross sections are averaged over a Maxwellian distribution for values of kT from 25 to 275 keV. When these cross sections are used in a nucleosynthesis calculation of the rare isotope ^{36}S, overproduction of this isotope, relative to the other nuclei formed in the universe, is reduced from a factor of 10 to 2.5.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

6016 (LBL—4029) **Mass measurements of highly neutron-excess nuclei in the light elements.** Wilcox, K.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1975. Contract W-7405-Eng-48. 102p. Dep. NTIS $6.50.

Thesis.

The ^{26}Mg(^{7}Li,^{8}B)^{25}Ne reaction at 78.9 MeV was used to measure the mass-excess of ^{25}Ne (-2.18 +- 0.10 MeV) and several low-lying excited states. Mass-excesses for ^{43}Ar (-31.98 +- 0.07 MeV), ^{45}Ar (-29.727 +- 0.06 MeV), and ^{46}Ar (-29.732 +- 0.07 MeV) were determined from the ^{48}Ca(α,^{9},^{7}Be)^{43},^{45}Ar reactions at 77.7 MeV and the ^{48}Ca(^{6}Li,^{8}B)^{46}Ar reaction at 80.1 MeV. Several excited states of ^{43}Ar and ^{45}Ar were observed. These and the excited states of ^{25}Ne are compared with theoretical predictions. Ground state differential cross sections are given for all reactions, ranging from 0.1 to 1 μb/sr at forward angles. Upper limits of about 1 to 25 nb/sr were determined for the ground state cross sections of the reactions ^{48}Ca(α,^{8},^{10},^{11}B)^{44},^{42},^{41}Cl and ^{48}Ca(α,^{10}-^{12}C)^{42}-^{38}S at 110 MeV. Recoil coincidence techniques were used to measure the mass-excess of the particle-unbound nucleus ^{10}Li(33.83 +- 0.25 MeV) by the ^{9}Be(^{9}Be,^{8}B)^{10}Li reaction at 121 MeV; the ground state cross section was 30 nb/sr. The ^{14}C(^{9}Be, ^{8}B)^{15}B reaction at 120 MeV was also investigated using coincidence techniques. Contamination problems only permitted determining a ground state cross section upper limit of 50 nb/sr. A simple mass relation is derived, similar in approach to the Garvey-Kelson method but taking more explicit account of shell effects. Comparison is made with the Garvey-Kelson relation, and predictions of masses and of the stability of neutron-excess light nuclei are given for both methods. The modified mass relation is shown to offer better account for highly neutron-excess nuclei, including the values reported here for ^{23}Ne and ^{43},^{45},^{46}Ar. (26 figures, 2 tables, 66 references) (auth)

RADIOACTIVE DECAY

6017 (LA—6116-MS) **ENDF/B-IV fission-product files: summary of major nuclide data.** England, T.R.; Schenter, R.E. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. Contract W-7405-Eng-36. 39p. (ENDF—223). Dep. NTIS $4.00.

The major fission-product parameters [sigma/sub th/, RI, tau/sub 1/2/, E-bar/sub β/, E-bar/sub γ/, E-bar/sub α/, decay and (n,γ) branching, Q, and AWR] abstracted from ENDF/B-IV files for 824 nuclides are summarized. These data are most often requested by users concerned with reactor design, reactor safety, dose, and other sundry studies. The few known file errors are corrected to date. Tabular data are listed by increasing mass number. (auth)

ENERGY LEVELS AND TRANSITIONS

6018 Forbidden transitions in the ^{48}Ca(d,p)^{49}Ca reaction. Metz, W.D.; Callender, W.D.; Bockelman, C.K. (Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). *Phys. Rev., C;* 12: No. 3, 827-844(Sep 1975).

In a measurement of the angular distribution of proton groups from the ^{48}Ca(d,p)^{49}Ca reaction at E/subd/=20 MeV, particular emphasis is placed on the observation of seven weak transitions to states below 5 MeV excitation. These distributions are analyzed using distorted-wave Born-approximation (DWBA) parameters fixed by fitting, at E/subd/=13.0, 16.0, and 19.3 MeV, the angular distributions of the elastically scattered deuterons and the protons populating the single-particle $2p_{3/2}$, $2p_{1/2}$, and $1f_{5/2}$ states. The DWBA model also fits the (d,p) data of other investigators at E/subd/=7.0 and 10.0 MeV. The same model is then applied to the seven weak transitions, for which earlier data are available at 7.5 and 10.0 MeV in addition to the new E/subd/=20 MeV data. New partial angular distributions at 9.0 MeV are helpful in resolving some discrepancies. For three of the weak transitions, older l assignments are confirmed, for two of them new l assignments are made, and for two transitions the observed behavior is incompatible with any reasonable DWBA model. All seven transitions can be explained as populating 2p-1h states formed by coupling a neutron to excited states of the ^{48}Ca core.

MOMENTS AND SPIN

6019 g factor of the 3.830 MeV (15/2⁺) level in ^{41}Ca. Young, L.E.; Sprouse, G.D.; Strottman, D. (Department of physics, State University of New York, Stony Brook, New York 11794). *Phys. Rev., C;* 12: No. 4, 1358-1359(Oct 1975).

The g factor of the 3.830 MeV level of ^{41}Ca has been measured by the time differential perturbed angular distribution method to be g=+0.29 +- 0.02. The reaction ^{27}Al(^{16}O, p,n)^{41}Ca was used to populate the state in a magnetic field of 58 kG. The measured g factor can be understood within the configuration $(d_{3/2}^{-1}\, f_{7/2}^{2})^{15/2+}$. The calculated g factor depends sensitively on the isospin character of the particle—hole interaction.

NUCLEAR REACTIONS AND SCATTERING

6020 (LBL—4067) **Effect of free-particle collisions in high energy proton and pion-induced nuclear reactions.** Jacob, N.P. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. Contract W-7405-ENG-48. 185p. Dep. NTIS $12.25.

Thesis.

The effect of free-particle collisions in simple "knockout" reactions of the form (a,aN) and in more complex nuclear reactions of the form (a,X) was investigated by using protons and pions. Cross sections for the ^{48}Ti(p,2p)^{47}Sc and the ^{74}Ge(p,2p)^{73}Ga reactions were measured from 0.3 to 4.6 GeV incident energy. The results indicate a rise in (p,2p) cross section for each reaction of about (25 +- 3) percent between the energies 0.3 and 1.0 GeV, and are correlated to a large increase in the total free-particle pp scattering cross sections over the same energy region. Results are compared to previous (p,2p) excitation functions in the GeV ener-

gy region and to (p,2p) cross section calculations based on a Monte Carlo intranuclear cascade-evaporation model. Cross section measurements for (π/sup +-/, πN) and other more complex pion-induced spallation reactions were measured for the light target nuclei ^{14}N, ^{16}O, and ^{19}F from 45 to 550 MeV incident pion energy. These measurements indicate a broad peak in the excitation functions for both (π,πN) and (π,X) reactions near 180 MeV incident energy. This corresponds to the large resonances observed in the free-particle π^+p and π^-p cross sections at the same energy. Striking differences in (π,πN) cross section magnitudes are observed among the light nuclei targets. The experimental cross section ratio sigma(π^-,π^-n)/sigma(π^+,πN) at 180 MeV is 1.7 +- 0.2 for all three targets. The experimental results are compared to previous pion and analogous proton-induced reactions, to Monte Carlo intranuclear cascade-evaporation calculations, and to a semiclassical nucleon charge exchange model. (108 references) (auth)

6021 Relative sizes of ^{40} ^{48}Ca from the scattering of 79 MeV α particles. Lerner, G.M.; Hiebert, J.C.; Rutledge, L.L. Jr.; Papanicolas, C.; Bernstein, A.M. (Cyclotron Institute and Physics Department, Texas AandM University, College Station, Texas 77843). *Phys. Rev., C;* **12**: No. 3, 778-794(Sep 1975).

The scattering of 79.1 MeV α particles from ^{40},^{48}Ca has been measured with high relative accuracy and analyzed with a folding model for the optical potential. The result for ΔR, the difference between the ^{40},^{48}Ca rms matter radii, is ΔR=0.05 plus-or-minus 0.04 fm. This result appears smaller than most previous measurements which employed Woods-Saxon potentials or diffraction analyses. Most of the discrepancies are removed when the definition of the matter radius used in each analysis is scrutinized. Combining ΔR with the results of electromagnetic experiments yields the relative neutron-proton radius difference in ^{48}Ca; R/subn/(48)-R/subp/(48) =0.03 plus-or-minus 0.08 fm. These results are compared with Hartree-Fock calculations which tend to produce larger differences. Possible reasons for this discrepancy are discussed.

6022 Test of scale invariance in ratios of muon scattering cross sections at 150 and 56 GeV. Watanabe, Y.; Hand, L.N.; Herb, S.; Russell, A.; Chang, C.; Chen, K.W.; Fox, D.J.; Kotlewski, A.; Kunz, P.F.; Loken, S.C.; Strovink, M.; Vernon, W. (Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14853). *Phys. Rev. Lett.;* **35**: No. 14, 898-901(6 Oct 1975).

Scale invariance is tested in ratios of muon scattering cross sections from an iron target at pairs of q^2 values ranging to 40 $(GeV/c)^2$ and differing by a factor of 3/8. The apparatus was changed with incident energy to preserve acceptance and resolution in scaled variables. The scale-noninvariant departure from unity of these ratios displays a statistically significant ω dependence. The effect exceeds the systematic uncertainty by a factor of 1.7.

6023 Observed deviations from scale invariance in high-energy muon scattering. Chang, C.; Chen, K.W.; Fox, D.J.; Kotlewski, A.; Kunz, P.F.; Hand, L.N.; Herb, S.; Russell, A.; Watanabe, Y.; Loken, S.C.; Strovink, M.; Vernon, W. (Physics Department, Michigan State University, East Lansing, Michigan 48824). *Phys. Rev. Lett.;* **35**: No. 14, 901-904(6 Oct 1975).

Scale noninvariance is observed in 150- and 56-GeV muon scattering from an iron target. In the range $1<q^2<40(GeV/c)^2$, νW_2 rises with q^2 at fixed ω'approximately-greater-than6 and falls at ω'approximately-less-than6. The scale breaking is statistically and systematically significant, and persists with alternative choices of scaling variable. It is parametrized roughly by a constant b=partial^{2}ln(νtimesW$_2$)/partialln(ω') partialln(q^2) with a value near 0.09.

6024 Fore-aft anisotropy in the radiative capture of 14-MeV neutrons. Arthur, E.D.; Drake, D.M.; Halpern, I. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **35**: No. 14, 914-917(6 Oct 1975).

Relative yields of capture photons have been observed for four nuclei at angles of 55degree, 90degree, and 125degree in bombardments with 14-MeV neutrons. The yields from ^{10}B, ^{29}Si, and ^{48}Ca show smaller fore-aft anisotropies than those observed in corresponding proton captures. This suggests that the forward peaking in (p,γ) reactions is due mainly to direct rather than collective capture amplitudes. Photons from ^{12}C(n,γ_0)^{13}C peak backward, but this peaking cannot be straightforwardly accounted for in terms of the interference between the collective excitations dominant in this energy region.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

6025 Mean life and collective effects of the 937 keV, 0^+ state in ^{72}Se: Evidence for nuclear coexistence. Ramayya, A.V.; Ronningen, R.M.; Hamilton, J.H.; Pinkston, W.T.; Garcia-Bermudez, G.; Robinson, R.L.; Kim, H.J.; Carter, H.K.; Collins, W.E. (Physics Department, Vanderbilt University, Nashville, Tennessee 37235). *Phys. Rev., C;* **12**: No. 4, 1360-1363(Oct 1975).

The $0^{+\prime}$ state at 937 keV in ^{72}Se is unusual in that it is only 75 keV above the first excited 2^+ state. The half-life $T_{1/2}$ of the $0^{+\prime}$ state was determined to be 15.8 +- 0.9 ns by delayed coincidence techniques. The ratio of the E0/E2 decays was measured to be 0.37 +- 0.23 and the reduced monopole matrix element rho was calculated to be 0.176/sub -0.070//sup +0.048/. The B(E2) value of the 75-keV transition was deduced to be 36 +- 7 single-particle units. This large B(E2) value indicates that the $0^{+\prime}$ state is collective. These data are interpreted in terms of a coexistence of spherical and deformed shapes.

NUCLEAR REACTIONS AND SCATTERING

6026 (ANL/NDM—11) Measured and evaluated fast neutron cross sections of elemental nickel. Guenther, P.; Smith, A.; Smith, D.; Whalen, J.; Howerton, R. (Argonne National Lab., Ill. (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1975. Contract W-31-109-Eng-38. 159p. Dep. NTIS $11.00.

Fast neutron total and scattering cross sections of elemental nickel are measured. Differential elastic scattering cross sections are determined from incident energies of 0.3 to 4.0 MeV. The cross sections for the inelastic neutron excitation of states at: 1.156 +- 0.015, 1.324 +- 0.015, 1.443 +- 0.015, 2.136 +- 0.013, 2.255 +- 0.030, 2.449 +- 0.030, 2.614 +- 0.020 and 2.791 +- 0.025 MeV are measured to incident neutron energies of 4.0 MeV. The total neutron cross sections are determined from 0.25 to 5.0 MeV. The experimental results are discussed in the context of optical and statistical models. It is shown that resonance width-fluctuation and correlation effects are significant. The present experimental and theoretical results, together with previously reported values, are used to construct a comprehensive evaluated elemental data file in the ENDF format. Some comparisons are made with previously reported evaluated files. In addition, some selected reactions which are widely used in dosimetry and other applications are presented as supplemental evaluated isotopic-data files. The numerical quantities are presented in tabular form. (3 tables, 29 figures) (auth)

6027 (UCRL—6028-T) Excitation functions of neutron-induced reactions. Tewes, H.A.; Caretto, A.A.; Miller, A.E.; Nethaway, D.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Jun 1960. 13p. (CONF-600901—1). Dep. NTIS $4.50.

From Nuclear and radiation chemical symposium; Chalk River, Ontario, Canada (6 Sep 1960).

Cross sections for neutron induced reactions on a variety of nuclei have been measured as a function of neutron energy between 8 and 15 MeV. Tabulations are given of the reactions completed as well as those currently under investigation, cross section measurements to date, and cross sections obtained by others for some of the reactions studied. (2 figures, 3 tables) (SDF)

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

6028 ^{13}C+^{144}Sm neutron-transfer reaction. Thornton, S.T.; Ford, J.L.C. Jr.; Friedland, E.; Wiedner, C.A.; Goldschmidt, M. (Max-Planck-Institut fur Kernphysik, Heidelberg, Germany and University of Virginia, Charlottesville, Virginia 22903). *Phys. Rev., C;* **12**: No. 3, 877-886(Sep 1975).

Angular distributions have been obtained for the ^{144}Sm(^{13}C,^{12}C)^{145}Sm and ^{144}Sm(^{13}C,^{14}C)^{143}Sm$_{0-72}$, and ^{146}Sm(^{13}C,^{14}C)^{145}Sm$_{1-10}$ reactions at 66 MeV. In addition, several states in ^{143}Sm and ^{145}Sm were identified by bombardment of ^{144}Sm in the reactions (^{13}C,^{14}C) and (^{12}C,^{12}C), respectively, at 72 MeV for θ=50degree. Optical model parameters were deduced and a full finite-range recoil distorted wave Born approximation analysis provided C^2S values and J/sup pi/ assignments for levels in ^{143}Sm and ^{145}Sm. The use of heavy-ion reactions in conjunction with light ion results is shown to be a useful nuclear spectroscopic tool.

6029 Decay of 5.8-min ^{149}Pm/subm/ and 10-sec ^{149}Pm/subg/ to levels of ^{149}Nd. Zalutsky, M.R.; Macias, E.S. (Department of Chemistry, Washington University, St. Louis, Missouri 63130). *Phys. Rev., C;* 12: No. 3, 997-1002(Sep 1975).

The nuclear level structure of ^{149}Nd has been investigated by studying the decay of 5.8-min ^{149}Pm/subm/ and 10-sec ^{149}Pm/subg/ with Ge(Li) γ-ray detectors. Sources were produced via the ^{141}Pr(^{3}He,4n) reaction. The study of ^{149}Pm/subg/ decay utilized a helium-jet recoil transport system. Fourteen γ rays were assigned ^{149}Pm/subm/ decay and nine were attributed to ^{149}Pm/subg/ decay. Decay schemes of ^{149}Pm/subm/ and ^{149}Pm/subg/ were constructed. Evidence for the low-spin members of the two-phonon triplet in ^{149}Nd is also presented.

6030 Systematic study of the structure of odd-mass lanthanum nuclei. I. Levels in ^{137}La from ^{137}Ce/sup m + g/ decay. Henry, E.A.; Smith, N.; Johnson, P.G.; Meyer, R.A. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* 12: No. 4, 1314-1320(Oct 1975).

The level structure of ^{137}La populated by the β decay of ^{137}Ce/subm/$^{+}$/subg/ was studied by γ-ray and conversion-electron spectroscopy using mass-separated sources, large-volume and Compton-suppressed Ge(Li) detectors, and a Si(Li) detector. Nine previously unreported transitions were observed and two more levels were established in ^{137}La. The ^{137}La level structure is discussed in terms of the weak-coupling model.

6031 Systematic study of the structure of odd-mass lanthanum nuclei. II. Levels in ^{135}La from ^{135}Ce decay. Henry, E.A.; Meyer, R.A. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* 12: No. 4, 1321-1335(Oct 1975).

The β decay of 17.6-h ^{135}Ce to levels in ^{135}La was studied b γ-ray and conversion-electron spectroscopy, and by extensive γ—γ-coincidence experiments. The use of mass-separated sources, a Compton-suppressed spectrometer, and the megachannel analyzer system for coincidence studies has enabled substantial extension of the experimental knowledge of ^{135}La. Seventy-three previously unreported transitions were observed in the singles and coincidence data. Six levels not proposed in earlier works are firmly established here, and two other levels are tentatively proposed. The level structure of ^{135}La is compared to the systematics of related nuclei and to qualitative interpretations of nuclear models that attempt to describe this nucleus.

NUCLEAR REACTIONS AND SCATTERING

6032 Valence component in the neutron capture cross section of ^{90}Zr. Boldeman, J.W.; Allen, B.J.; de L. Musgrove, A.R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights); Macklin, R.L. (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Phys., A;* 246: No. 1, 1-20(14 Jul 1975).

6033 ^{106}Ag and ^{107}Ag with the (p, t) reaction. Del Vecchio, R.M.; Oelrich, I.C.; Naumann, R.A. (Joseph Henry Laboratories, Princeton University, Princeton, New Jersey 08540). *Phys. Rev., C;* 12: No. 3, 845-855(Sep 1975).

The ^{107,109}Ag(p, t)^{105,107}Ag reactions have been studied at 30 MeV bombarding energy. Tritons were detected with a 60 cm position-sensitive wire proportional counter backed by a plastic scintillator in the focal plane of a quadrupole-dipole-dipole-dipole (QDDD) spectrograph. Multiplet structure, interpretable as the coupling of a $2p_{1/2}$ proton to vibrational core states, was observed in both nuclei. In addition, some 50 levels in each nucleus were seen below about 3 MeV of excitation with a resolution of 10 keV. DWBA calculations with simple two particle configurations worked rather well and permitted the determination of L transfers. A considerable amount of (p, t) strength in the region from 2-3 MeV of excitation in each nucleus was observed, not all of which could be associated with expected weak coupling to the 3^{-} core state.

6034 Internal conversion studies in ^{144}Nd. Avignone, F.T. III; Raman, S. (Department of Physics, University of South Carolina, Columbia, South Carolina 29208). *Phys. Rev., C;* 12: No. 3, 963-966(Sep 1975).

The relative electron intensities of eight transitions in ^{144}Nd were measured with a combination magnetic-Si(Li) spectrometer. The deduced internal conversion coefficients were compared with theoretical values in order to determine the multipolarity assignments for these transitions. With the assumption that the 618.0-keV transition is E2, the 476.8-, 582.4-, and 696.5-keV transitions were also found to be E2. The 301.7-, 778.6-, and 814.1-keV transitions were found to be predominantly E1. Our results are consistent with an E0+M1+E2 assignment for the 890.1-keV transition. The internal conversion studies confirm the spin and parity assignments for four excited states in ^{144}Nd which were previously proposed mainly on the basis of angular correlation measurements.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

RADIOACTIVE DECAY

6035 Half-life and decay of the long-lived isomer of ^{150}Eu. Nethaway, D.R.; Mendoza, B.; Newbury, R.S. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., C;* 12: No. 4, 1310-1313(Oct 1975).

The half-life of the long-lived isomer of ^{150}Eu has been measured to be 35.8 +- 1.0 yr. Two methods were used for the measurements. In the first, the ^{150}Eu half-life was measured relative to that of ^{147}Eu, ^{148}Eu, ^{149}Eu, and ^{152}Eu by measuring the atom ratios and disintegration-rate ratios in a mixed tracer solution using mass-spectrometric and Ge(Li) counting techniques. The second method involved studying the γ spectrum of three mass-separated ^{150}Eu sources over periods of up to 6.1 yr with several NaI(Tl) detectors. No evidence was found for the 6.2 yr half-life which has been previously reported for ^{150}Eu.

ENERGY LEVELS AND TRANSITIONS

6036 Ground states in the neutron-deficient 165less than or equal toAless than or equal to185 region. Harmatz, B.; Horen, D.J.; Ellis, Y.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* 12: No. 3, 1083-1086(Sep 1975).

In the rare-earth deformed region, shifts from systematic Nilsson ground-state assignments are suggested for ^{177}W, ^{181}Os, and for ^{171,173}Ta. Other proposed changes in the regular ordering of Nilsson ground states in the 71less than or equal toZless than or equal to77 region far from the β-stability line are discussed.

MOMENTS AND SPIN

6037 Nuclear magnetic dipole moment of ^{181}Ta. Sugar, J.; Kaufman, V. (National Bureau of Standards, Washington, D.C. 20234). *Phys. Rev., C;* 12: No. 4, 1336-1339(Oct 1975).

The hyperfine structure of the $6s\ ^{2}S_{1/2}$—$6p\ ^{2}P_{1/2}$ line of Ta v at 1708 A has been resolved using a 150 A sliding spark discharge. The 6p—8s multiplet was identified and the ionization energy was redetermined. With these new data a value for the nuclear dipole moment of ^{181}Ta of (2.36 +- 0.02) μ/sub N/ is derived. New wavelengths are given for all previously classified lines.

NUCLEAR REACTIONS AND SCATTERING

6038 (UCID—16958) Investigation of the dependence of γ-ray spectral shape on the averaging interval size for the ^{181}Ta(n,γ) reaction. Stelts, M.L.; Browne, J.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Nov 1975. Contract W-7405-Eng-48. 12p. Dep. NTIS $4.50.

The dependence of the shape of neutron capture γ-ray spectra on the averaging interval size has been investigated for the ^{181}Ta (n,γ) reaction. The effects of statistical fluctuations in the partial radiation widths are discussed. The change in the spectral shape as a function of neutron energy is presented. (auth)

6039 Character of the 1775 keV state in ^{184}W. Casten, R.F.; Macphail, M.R.; Kane, W.R. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* 12: No. 3, 821-826(Sep 1975).

The populations of levels in ^{184}W in the (n,γ) reaction are studied. On the basis of the technique of population systematics it is argued that the 1713 and 1775 keV levels are not the 1^{+} and 2^{+} members of a K=1 rotational band as recently proposed. Rather it is shown that the 1775 keV level is most likely a K=2 bandhead. Arguments from earlier charged particle reaction data support these conclusions whose implications are important in the study of the breakdown of the Nilsson model in this mass region. An assessment is made of current interpretations of the states between 1600 and 1900 keV in ^{184}W.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

6040 Isomerism in ^{194}Au. Yates, S.W.; Lynch, F.J. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* 12: No. 3, 1080-1082(Sep 1975).

Isomeric states in ^{194}Au with half-lives of 600plus-or-minus8 and 420plus-or-minus10 ms have been studied by observing the delayed γ rays following the ^{194}Pt(p,n) and ^{194}Pt(d,2n) reactions. γ-ray singles and γ-γ coincidence measurements were made and

isomer cross section ratios were calculated. It is argued that the isomer at 80.5 keV has the shell model configuration ($\pi d_{3/2}$, $\nu i_{13/2}$)5$^+$, while the higher-lying isomer is believed to decay by an unobserved isomeric transition.

NUCLEAR REACTIONS AND SCATTERING

6041 (COO—1672-61) **Radiochemical investigations of nuclear properties. Progress report, 1 October 1974—30 September 1975.** Daly, P.J. (Purdue Univ., Lafayette, Ind. (USA). Dept. of Chemistry). Sep 1975. Contract AT(11-1)-1672. 20p. Dep. NTIS $4.50.

Further studies of the structure of nuclei in the A = 180-200 shape transitional region have been performed. The principal project completed during the current year was an extensive in-beam γ-ray investigation of high-spin levels in the nine nuclei ^{188}Pt to ^{194}Pt by (α,xnγ) reactions on enriched Os targets. Acute backbending observed in the positive parity yrast sequences of ^{188,190,192,194}Pt has been attributed to the intersection of rotation-aligned (νi-^{2}/sub 13/2/) and (πh^{-2}/sub 11/2/) bands with the ground bands. In all four odd-A Pt nuclei, decoupled νi^{-1}/sub 13/2/ bands and many other low-lying high-spin positive parity levels have been established, and low-spin positive parity levels have been located in complementary decay studies. A model of an i/sub 13/2/ neutron hole coupled to a triaxially deformed core has been found to be rather successful in reproducing these complex level spectra. Other topics dealt with include new μs isomers in ^{187,189}Pt, the decays of ^{193}Au, /sup 194m/Ir and 1.7 h ^{188}Ir and the level structure of ^{191}Au from an ^{191}Ir(alpha,4nγ) study. (auth)

6042 **^{208}Pb(^{18}O,^{15}O)^{209}Pb reaction.** Becchetti, F.D.; Harvey, B.G.; Kovar, D.; Mahoney, J.; Maguire, C.; Scott, D.K. (Cyclotron Laboratory, Department of Physics, The University of Michigan, Ann Arbor, Michigan 48104 and Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev., C;* 12: No. 3, 894-900(Sep 1975).

The neutron levels in ^{209}Pb have been studied with the ^{208}Pb(^{18}O,^{15}O) reaction at a bomdarding energy of 139 MeV. Spectroscopic factors (S) have been deduced using a finite-range distorted-wave Born approximation (DWBA) with recoil. The $2g_{9/2}$, $1i_{11/2}$, $2g_{7/2}$, and $3d_{5/2}$ levels are found to have S approximately-greater-than 0.9 while S $\cong$ 0.7 for the $1j_{15/2}$ level at 1.4 MeV excitation. Evidence is found for other $1j_{15/2}$ fragments being at 3.05 MeV and ~ 3.8 MeV with S $\cong$ 0.08 and 0.26, respectively, which would place the centroid of the $1j_{15/2}$ level at E/subx/ $\cong$ 2.2 MeV. DWBA predicts a shift in the maxima of the angular distributions as a function of Q value which is not observed experimentally. A comparison with the proton transfer reaction ^{208}Pb(^{16}O,^{15}N)^{209}Bi has been used to deduce the geometrical parameters of a neutron shell model potential appropriate for nuclei with A approximately-greater-than 200. The parameters of this Wood-Saxon potential are: V/subR/=-50.5 MeV,r/subR/=1.19 fm, a/subR/=0.75 fm, V)=-5.5 MeV, r)=1.01 fm, and a)=0.75 fm.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

RADIOACTIVE DECAY

6043 **Search for an anisotropy between Ll x rays and γ rays in the decay of ^{243}Cm.** Zalutsky, M.R.; Macias, E.S. (Department of Chemistry, Washington University, St. Louis, Missouri 63130). *Phys. Rev., C;* 12: No. 3, 1076-1079(Sep 1975).

The anisotropy of Ll x rays and γ rays of ^{239}Pu following the decay of ^{243}Cm has been investigated. A Ge(Li) crystal with 250 eV resolution at 5.9 keV was used to detect Ll x rays. A NaI(Tl) crystal was used to detect six γ rays between 210 and 285 keV. The measured anisotropy is A= (3plus-or-minus6) times10^{-3}. This is less than 2% of the maximum predicted anisotropy assuming that the magnetic substate alignment has been completely retained in the coupling of cascade γ rays and x rays.

ENERGY LEVELS AND TRANSITIONS

6044 **Collective states in ^{230}Th, ^{240}Pu, ^{244}Pu, and ^{248}Cm excited by inelastic deuteron scattering.** Thompson, R.C.; Huizenga, J.R.; Elze, T.W. (Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York 14627). *Phys. Rev., C;* 12: No. 4, 1227-1235(Oct 1975).

Energy spectra of inelastically scattered 16-MeV deuterons were measured at angles of 90° and 125° using enriched target of ^{230}Th, ^{240}Pu, ^{244}Pu, and ^{248}Cm. In each nucleus the ground state band is observed up to and including the J/sup π/ = 8$^+$ level. The β vibration J/sup π/ = 0$^+$ level is identified in ^{230}Th, and in this and the remaining three nuclei evidence for the γ vibration is discussed. At least octupole bands are observed in each nucleus, and K,J/sup π/ assignments are made in a number of cases. B(E2) and B(E3) values are extracted for selected levels.

NUCLEAR REACTIONS AND SCATTERING

6045 (LA-UR—75-1747) **Status of neutron cross sections of transactinium isotopes in the resonance and fast energy regions: underground nuclear explosion measurements.** Moore, M.S. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-eng-36. 28p. (CONF-751104—1). Dep. NTIS $4.50.

From IAEA advisory group meeting on transactinium isotope nuclear data; Karlsruhe, F.R. Germany (3 Nov 1975).

The nuclear explosion technique as a means of obtaining neutron cross-section data of actinide isotopes with half-lives of the order of days or longer is reviewed. The status of measurements previously made in this region (except for ^{232}Th, ^{233}U, ^{235}U, ^{238}U, and ^{239}Pu) is discussed. Some suggested corrections which may be in order for previously published data are described, and recommendations are made for possible future work by this technique. (6 figures, 4 tables, 45 references) (auth)

6046 (ORNL-tr—4040) **Experiments on chemical identification of spontaneously fissionable isotope of element 105.** Zvara, I.; Belov, V.Z.; Korotkin, Yu.S.; Shalaevsky, M.R.: Shchegolev, V.A.; Hussonnois, M.; Zager, B.A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. Translation by M. Gerrard of JINR—P12-5120. 16p. Dep. NTIS $4.50.

Experiments have been performed on the chemical separation of radioactive products obtained in the bombardment of americium-243 with accelerated neon-22 ions (compound nucleus-element 105) by adsorption of gaseous chlorides from flowing carrier gas on the surface of a glass tube, over which a temperature gradient was established. It was found that the chloride of the spontaneous fission activity present is less volatile than niobium chloride but not less volatile than hafnium chloride. Such volatility properties are predicted for element 105-ehatantalum. 18 decay events were detected. (2 tables, 1 figure) (auth)

6047 **Octupole states in ^{246}Cm and ^{248}Cm populated by inelastic deuteron scattering.** Yates, S.W.; Friedman, A.M.; Ahmad, I. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* 12: No. 3, 795-800(Sep 1975).

Vibrational states in ^{246}Cm and ^{248}Cm have been investigated by inelastic deuteron scattering. The K/sup pi/=0$^-$, 1$^-$, and 2$^-$ octupole states are identified in ^{246}Cm at 1251, 1080, and 842 keV, respectively. In ^{248}Cm several excited states above 1 MeV have been identified; however, definite assignments for these states, except a J/sup pi/=3$^-$ state at 1095 keV and a J/sup pi/=2$^+$ state at 1050 keV, could not be made. Differences between the ^{246}Cm and ^{248}Cm level spectra are interpreted in terms of their microscopic components. Reduced transition probabilities B (E3) are extracted for the observed J/sup pi/=3$^-$ levels and are compared with theoretical values available in the literature.

SPONTANEOUS AND INDUCED FISSION

6048 (CONF-750303—76) **Manganese bath systematic effects in measurements of nu-bar and eta.** Smith, J.R. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. 4p. Dep. NTIS $4.50.

From Proceedings on nuclear cross section and technique; Washington, District of Columbia, USA (3 Mar 1975).

Measurements using the manganese bath technique are central to the discrepancy that has existed between measured values of ν-bar for ^{252}Cf. Manganese bath measurements of ν-bar belong to the lower group of values, while the eta measurements are consistent with the higher ν-bar values. A three-part study was performed to see if the discrepancy could be explained by differences in manganese bath techniques: (1) A ^{252}Cf source previously calibrated by De Volpi was calibrated in the MTR manganese bath; (2) The recommendations made by De Volpi for altering the MTR eta values were carefully considered; and (3) The results of the Monte Carlo calculation of the MTR experiments, carried out at Bettis Atomic Power Laboratory, were examined in detail. The study produced insignificant changes in the eta values. (6 tables) (auth)

6049 (CONF-751104—2) **General survey of applications which require actinide nuclear data.** Raman, S. (Oak Ridge National Lab., Tenn. (USA)). 1975. 84p. Dep. NTIS $6.00.

From IAEA advisory group meeting on transactinium isotope nuclear data; Karlsruhe, F.R. Germany (3 Nov 1975).

The actinide waste problem, the buildup of toxic isotopes in the fuel, the neutron activity associated with irradiated fuel, the ^{252}Cf buildup problem, and the production of radioisotope power sources as broad areas that require actinide cross-section data are

reviewed. Decay data enter into the area of radiological safety and health physics. A few cross-section measurements in progress at the Oak Ridge Electron Linear Accelerator are also discussed. The availability of actinide samples through the Transuranium Program at Oak Ridge is discussed in considerable detail. The present data status with respect to the various applications is reviewed along with recommendations for improving the data base. (auth)

6050 (UCRL—51925) **Measurement of the neutron-induced fission cross section of ^{241}Pu relative to ^{235}U from 0.001 to 30 MeV.** Behrens, J.W.; Carlson, G.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Oct 1975. Contract W-7405-Eng-48. 27p. Dep. NTIS $4.00.

The ratio of the neutron-induced fission cross sections of ^{241}Pu relative to that of ^{235}U was measured with fission ionization chambers at the LLL 100-MeV electron linear accelerator. The time-of-flight technique was used to measure the cross-section ratio as a function of neutron energy from 0.001 to 30 MeV. The continuous energy spectrum of the neutron source allowed us to cover the entire energy range in one measurement. Pulse height distributions were also measured as functions of energy over broad energy bands. These data were used to estimate the energy variation in the efficiency to be less than 0.75 percent. The threshold cross-section method normalized the ratio independent of other cross-section measurements to 1.268 +- 0.022 in the interval 1.75 to 4.00 MeV. The ratio was also taken to thermal neutron energy where it was normalized to evaluated thermal fission cross sections and the resulting ratio in the 1.75- to 4.00-MeV interval was 1.242 +- 0.021. Corrected for the impurities in the ^{241}Pu sample, the average of these two values resulted in a ^{241}Pu:^{235}U fission cross-section ratio of 1.251 +- 0.016 for the normalization interval. Typical energy resolution is 5 percent at 20.0, 1.0, and 0.1 MeV. Most of the data have counting uncertainties smaller than 4 percent, expressed as a standard deviation. Systematic errors are discussed, and current results are compared with previous measurements. Tables of our data are included. (9 tables, 8 figures) (auth)

6051 **Very low energy photofission of ^{238}U.** Bowman, C.D.; Schroder, I.G.; Dick, C.E.; Jackson, H.E. (National Bureau of Standards, Washington, D.C. 20234). *Phys. Rev., C;* **12**: No. 3, 863-870(Sep 1975).

The photofission cross section of ^{238}U was measured in the 2.75- to 5.75-MeV range. Cross sections as small as 2×10^{-11} b were detected. A shelf was observed which had been predicted to occur in the cross section owing to the dominance of radiative decay of levels in the second well. Barrier penetrabilities for both inner and outer barriers were determined from these measurements and together with penetrabilities from other measurements were used to infer a potential shape for ^{238}U. The total γ-ray strength function in the second well at 4.25 MeV was found to be 1.3×10^{-5}. From comparison of expected and measured cross sections at the lowest energies, the density of levels effective in photofission at 3 MeV was found to be greater than 4 per MeV.

NUCLEAR THEORY

NUCLEAR STRUCTURE

6052 **Test of many-body methods on an exactly soluble model with backbending and gapless superconductivity.** Chu, S.Y.; Marshalek, E.R.; Ring, P.; Krumlinde, J.; Rasmussen, J.O. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., C;* **12**: No. 3, 1017-1034(Sep 1975).

The exactly soluble R(8) model of Krumlinde and Szymanski is used as a testing ground for three many-body methods applied to the yrast band: (i) the self-consistent cranking model, (ii) self-consistent cranking plus random phase approximation, and (iii) variation after projection of particle number. All three methods agree very well with exact results outside of the critical region. The behavior in the critical region is examined in detail.

NUCLEAR MATTER

6053 (ORO—4856-22) **Quasiparticle interaction in nuclear matter.** Poggioli, R.S.; Jackson, A.D. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy; New York Univ., N.Y. (USA). Dept. of Physics). Jul 1975. 51p. Dep. NTIS $5.50.

A microscopic calculation of the quasiparticle interaction in nuclear matter is detailed. In order to take especial care of the contributions from the low momentum states, a model space is introduced. Excluded from the model space, the high momentum states are absorbed into the model interaction. Brueckner theory suggests the choice of a truncated G-matrix as a good approximation for this model interaction. A simple perturbative approach is attempted within the model space. The calculated quasiparticle interaction is consistent with experimental results. (11 tables, 14 figures) (auth)

6054 (ORO—4856-36) **Vertex and propagator renormalizations in nuclear calculations.** Poggioli, R.S. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Oct 1975. 7p. Dep. NTIS $4.50.

It has been asserted that vertex renormalizations tend to cancel the effects of propagator renormalizations in nuclear calculations. In order to test this hypothesis, those contributions to the quasiparticle interaction in nuclear matter which represent the effect of the simplest vertex and propagator renormalizations have been evaluated. Unfortunately, almost no cancellation of effects was found to exist. (auth)

6055 **Chiral symmetry and pion condensation. I. Model-dependent results.** Campbell, D.K.; Dashen, R.F.; Manassah, J.T. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544 and The Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Rev., D;* **12**: No. 4, 979-1009(15 Aug 1975).

The successes of current algebra and partial conservation of axial-vector current can be interpreted as indications that the strong interactions are approximately symmetric under chiral Su(2) times SU(2) transformations. In the absence of matter, the explicit chiral-symmetry breaking defines a unique vacuum state for the theory. The smallness of the chiral-symmetry breaking, however, implies the existence of many other states, approximately degenerate in energy with, but orthogonal to, the true vacuum. In these states, in general $< \pi >$ does not equal 0; thus they contain a "pion condensate." In a macroscopic system - such as a neutron star - at very high baryon density one of these pion-condensed states might become the true ground state. We study this phenomenon in the linear σ model. We are able to calculate analytically the "phase diagram" describing the ground state of infinite nuclear matter as a function of baryon density. Above a critical baryon density a phase transition to a pion-condensed ground state occurs. We extend the chiral-symmetry approach to include the effects of the N* (1236) and the ill-understood γ-N s waves. In addition to analyzing the ground state, we examine the spectrum of excited states. In the condensed phase, the meson excitation spectrum contains a "Goldstone boson" associated with the ground state's not being an eigenstate of the conserved operator I_2. However, when electromagnetic interactions are included, this mode disappears via the Higgs phenomenon indicating that the ground state is a superconductor. The presence of the pion condensate fosters the β decay of the fermion excitations, and the emitted neutrinos provide the cooling mechanism for neutron stars.

6056 **Chiral symmetry and pion condensation. II. General formalism.** Campbell, D.K.; Dashen, R.F.; Manassah, J.T. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544 and The Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Rev., D;* **12**: No. 4, 1010-1025(15 Aug 1975).

The role of chiral symmetry in pion condensation was explored through model calculations in the preceding paper. Here we present model-independent results which justify and sometimes go beyond the previous work. Our methods are based on functional techniques used in field theory. The paper is not self-contained and is meant to be read in conjunction with the preceding one. In the course of this work we were led to look at low-energy π-N interactions. In a brief survey, it is pointed out that they are more complicated than is commonly assumed.

NUCLEAR REACTIONS AND SCATTERING

6057 **Folded potentials for the description of heavy ion elastic scattering and transfer reactions.** Dover, C.B.; Vary, J.P. (Brookhaven National Lab., Upton, N.Y. (USA)). pp 1-14 of In Classical and quantum mechanical aspects of heavy ion collisions. Harney, H.L. (ed.). Berlin; Springer-Verlag (1975).

From Classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F.R. Germany (2 Oct 1974).

6058 (LBL—4212) **Neutron production from heavy ion interaction: some very empirical considerations.** Rindi, A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 11 Jul 1975. Contract W-7405-eng-48. 24p. (CONF-751025—1). Dep. NTIS $4.25.

From Course on high energy radiation dosimetry and protection; Erice, Italy (1 Oct 1975).

In the last few years there has been increasing interest in the use of heavy ion accelerators for research in nuclear physics, radiobiology, medicine and space science. Neutrons of energy up

to that of the primary accelerated heavy ion may be produced by interaction with matter. The knowledge of the yield and energy spectrum of these neutrons is of fundamental importance in all the fields of application of heavy ions. Very little is known from the theoretical as well as experimental point of view about the production of these neutrons. The theory associated with neutron production is summarized and the scarce experimental results accumulated up to now are reported. (7 figures, 5 tables) (auth)

6059 (LBL—4296) **Macroscopic description of the interaction between two complex nuclei.** Swiatecki, W.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-Eng-48. 13p. (CONF-750938—2). Dep. NTIS $4.50.

From Seminar on reactions of heavy ions with nuclei and synthesis of new elements; Dubna, USSR (23 Sep 1975).

Assuming that the particle number is large, and using the leptodermous idealization that the ratio of the surface thickness to the cube root of nuclear volume is very small, an attempt is made to give an account of the time evolution of the shape of a nuclear system. It is suggested that a one-body, dissipation dominated approach to nuclear dynamics should be a reasonable starting point. (SDF)

6060 Oscillations in the angular distributions of heavy-ion transfer reactions. Garrett, J.D. (Brookhaven National Lab., Upton, N.Y. (USA)). pp 59-85 of In Classical and quantum mechanical aspects of heavy ion collisions. Harney, H.L. (ed.). Berlin; Springer-Verlag (1975).

From Classical and quantum mechanical aspects of heavy ion collisions; Heidelberg, F.R. Germany (2 Oct 1974).

6061 Electromagnetic corrections to the induced pseudoscalar term in nuclear muon capture. Fulcher, L.P. (Univ. of Maryland, College Park); Mukhopadhyay, N.C. *Nuovo Cim., A;* **28A**: No. 4, 487-509(21 Aug 1975).

The electromagnetic corrections to the induced pseudoscalar term in nuclear muon capture are studied. The effects of the static nuclear magnetic field are shown to be very small. The effects of the nuclear Coulomb field are calculated by constructing the Green's function appropriate for pions moving in the Coulomb field of an extended nucleus and using realistic muon wave functions. Consideration of finite nuclear size is shown to be imperative in order to obtain accurate results. The Coulomb corrections are not large enough to play any significant role in understanding the discrepancy of the theory with the recent measurement of the photon spectrum following radiative muon capture in ^{40}Ca of the rate of the reaction $^{16}O(\mu^-, \nu/\text{sub mu})^{16}N(0^-)$. Two approximate methods of obtaining the results are also presented. (auth)

6062 Direct reaction effects on compound cross sections. Moldauer, P.A. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **12**: No. 3, 744-756(Sep 1975).

Two effects of a direct reaction on compound processes are discussed: the enhancement of the average compound cross section that competes with the direct process and the cross correlations in the fluctuations of cross sections involving the directly coupled channels. For the case of two directly coupled channels it is shown that both effects are maximized at the causality limit of the average S matrix where the penetration matrix P is singular. Computer experiments demonstrate that both effects fall off sharply when S is not near this causality limit and similar reductions in the effects are expected when more than two channels are strongly coupled to one another. A formula based upon the Engelbrecht-Weidenmuller transformation and the M-cancellation principle gives an excellent account of the enhancements obtained from the computer experiments. It also gives a qualitative account of the magnitudes of the cross section cross correlation coefficients. A somewhat more complicated formula due to Hofmann et al. also gives a good account of the enhancements. Both of these formulas agree with that of Kawai et al. in the limit of large width-to-spacing ratios.

6063 Relativistic angular momentum relationships for high-energy heavy-ion reactions. Bertini, H.W.; Larson, N.M. (Neutron Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **12**: No. 3, 871-876(Sep 1975).

Established properties of the relativistic intrinsic and orbital angular momentum tensors are reviewed, and relationships between the components of these tensors are derived. These relationships reduce the number of unknowns that must be determined for the calculation of the relativistic spin of the heavy fragments in high-energy heavy-ion interactions, in the limit where quantum mechanics may be ignored. An example using the intranuclear-cascade model is presented.

6064 Propagation in nonlocal optical potentials. Lenz, F.; Moniz, E.J. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., C;* **12**: No. 3, 909-914(Sep 1975).

It is shown that a nonlocal optical potential implies multiple eigenmode propagation. This is important when the mean free path becomes of the order of the nonlocality, such as in the strong absorption situation occurring for pion scattering near the 3-3 resonance, and consequently the propagation cannot be described reasonably by one complex wave number. The eigenmode structure can be seen most directly in quasielastic scattering.

6065 Energy and angular momentum dependence of complete fusion cross sections. Seglie, E.; Sperber, D. (Rensselaer Polytechnic Institute, Troy, New York 12181). *Phys. Rev., C;* **12**: No. 4, 1236-1241(Oct 1975).

A model for the calculation of the cross section for complete fusion in heavy-ion reactions is suggested. The model does not explicitly depend on the sharp cutoff approximation. On the contrary, it allows for a gradual transition between compound and direct process when the bombarding energy is sufficiently high above the Coulomb barrier. The energy below which the reaction cross section is exhausted by compound processes is also estimated. Comparison with experimental results supports the validity of the model.

6066 Shell model theory of radiative pion capture. Vergados, J.D. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). *Phys. Rev., C;* **12**: No. 4, 1278-1293(Oct 1975).

The formalism for calculating the radiative pion capture cross section has been developed for shell model calculations in the impulse approximation. It includes the momentum-dependent terms of the effective transition operator for any angular momentum of the pion. The giant dipole and giant quadrupole resonances are discussed. The quasifree background is calculated within the framework of the distorted-wave impulse approximation. Realistic shell model calculations for ^{16}O yield good agreement with experiment.

6067 Relativistic hydrodynamic theory of heavy-ion collisions. Amsden, A.A.; Bertsch, G.F.; Harlow, F.H.; Nix, J.R. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). *Phys. Rev. Lett.;* **35**: No. 14, 905-908(6 Oct 1975).

By use of finite-difference methods the classical relativistic equations of motion for the head-on collision of two heavy nuclei are solved. For ^{16}O projectiles incident onto various targets at laboratory bombarding energies per nucleon less than or equal to2.1 GeV, curved shock waves develop. The target and projectile are deformed and compressed into crescents of revolution. This is followed by rarefaction waves and an overall expansion of the matter into a moderately wide distribution of angles.

6068 Reactive content of the single-scattering optical potential. Tandy, P.C.; Redish, E.F.; Bolle, D. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev. Lett.;* **35**: No. 14, 921-924(6 Oct 1975).

A unitarity relation is derived for the nucleon-nucleus scattering amplitude which displays the reaction mechanisms associated with the absorptive part of the single-scattering optical potential. The reactions implicit in the absorption are nucleon pickup and knockout. The transition amplitudes for these processes are extracted from the unitarity relation and their accuracy is discussed.

NUCLEAR MOMENTS AND SPIN

6069 Differences of deformation parameter β for different transition mechanisms; comparison with data. Madsen, V.A.; Brown, V.R.; Anderson, J.D. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **12**: No. 4, 1205-1211(Oct 1975).

The differences between the isovector and isoscalar parts of the collective deformation parameter β are obtained from the results of microscopic effective-charge theory. For single-closed-shell nuclei, differences, due to the isovector parts, of up to about 20% between $\beta/\text{sub nn}'/$ and $\beta/\text{sub pp}'/$ are predicted, $\beta/\text{sub nn}'/$ being much closer to $\beta/\text{sub em}/$ than to $\beta/\text{sub pp}'/$. Data on single-closed-shell nuclei are tabulated and their general trend supports our predictions.

NUCLEAR MODELS

6070 (LBL—4317) **Nuclear interaction potential in a folded-Yukawa model with diffuse densities.** Randrup, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-Eng-48. 38p. Dep. NTIS $4.00.

The folded-Yukawa model for the nuclear interaction potential is generalized to diffuse density distributions which are generated by folding a Yukawa function into sharp generating distributions. The effect of a finite density diffuseness or of a finite interaction range is studied. The Proximity Formula corresponding to the generalized model is derived and numerical comparison is made with the exact results. (8 figures) (auth)

6071 Observation of the recoil proton in quasielastic pion scattering. Silbar, R.R.; Stupin, D.M. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). *Phys. Rev., C;* 12: No. 3, 1089-1092(Sep 1975).

A semiclassical model is developed to give a first estimate of the expected cross section for observation of the recoil proton in quasielastic pion scattering. Advantages of detecting the proton, rather than the scattered pion, are discussed.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

6072 (CONF-750927—4) **Degradation spectra and ionization yields of electrons in gases.** Inokuti, M.; Douthat, D.A.; Rau, A.R.P. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 33p. Dep. NTIS $4.75.

From 5. symposium on microdosimetry; Varbania Pallanza, Italy (22 Sep 1975).

Progress in the microscopic theory of electron degradation in gases by Platzman, Fano, and co-workers is outlined. The theory consists of (1) the cataloging of all major inelastic-collision cross sections for electrons (including secondary-electron energy distribution in a single ionizing collision) and (2) the evaluation of cumulative consequences of individual electron collisions for the electrons themselves as well as for target molecules. For assessing the data consistency and reliability and extrapolating the data to the unexplored ranges of variables (such as electron energy), a series of plots devised by Platzman are very powerful. Electron degradation spectra were obtained through numerical solution of the Spencer—Fano equation for all electron energies down to the first ionization thresholds for a few examples such as He and Ne. The systematics of the solutions resulted in the recognition of approximate scaling properties of the degradation spectra for different initial electron energies and pointed to new methods of more efficient treatment. Systematics of the ionization yields and their energy dependence on the initial electron energy were also recognized. Finally, the Spencer—Fano equation for the degradation spectra and the Fowler equation for the ionization and other yields are tightly linked with each other by a set of variational principles. (52 references, 7 figures) (DLC)

6073 (JUL—1204) **Electronic energy loss of fast molecules in matter.** Steinbeck, J. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Material- und Festkoerperforschung). Jun 1975. 174p. (In German). Dep. NTIS (US Sales Only) $11.75.

Thesis. Submitted to Technische Hochschule, Aachen.

In high velocity collisions of molecular ions the correlated motion influence of the ion cores on the electronic energy loss is investigated. The stopping power in the first Born approximation for a random arrangement of target atoms can be formulated in terms of the inelastic electronic structure factor. In treating the target atoms in Hartree-Fock approximation each electron can be regarded as stopping the ion independent of all other electrons without restriction by the Pauli principle. A second equivalent formulation of the stopping power leads to the dielectric function of the target. The results are applied to the stopping of H_2^+-ions. For vanishing distance between the two protons the stopping power per particle is twice that for single proton collisions. For distances in the order of the Bohr radius the correlated stopping power may even be smaller than for uncorrelated protons. With increasing distances the correlation influence vanishes. The stopping of H_2^+-ions in C, Si und Ge is discussed using Clementi wave functions for the core electrons and a free electron approximation with Lindhard's dielectric function for the valence electrons. The comparison with the only experimental result available for H_2^+ in C at 300 keV yields qualitative agreement. (auth)

6074 (UCID—16865) **Thin foil electron beam impulse experiments.** Kvam, K.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Jul 1974. Contract W-7405-Eng-48. 31p. Dep. NTIS $4.75.

Measurements were made of the impulse produced by thin, metallic foils that had been rapidly and uniformly heated in depth, to melt or vaporization by an electron beam. Blowoff predictions were done using two hydrocodes: PUFF, with the GRAY three phase equation of state, and CHART, with its three phase equation of state. An acceptable correlation variable, folding in electron beam and material characteristics, was derived and used successfully to plot and analyze predicted and measured data trends. We conclude that PUFF and CHART, with their present equations of state, predict impulse correctly within tolerances of +-30 percent. Unfortunately, the lack of repeatability of the electron beam machine precludes its use for doing more accurate equation of state measurements. (9 figs, 5 tables, 10 refs.) (auth)

6075 Feasibility of coherent x-ray production by x-ray pumping. Csonka, P.L.; Crasemann, B. (Univ. of Oregon, Eugene). *Phys. Rev., A;* 12: No. 2, 611-614(Aug 1975).

It is suggested that coherent soft x rays can be produced by inverting the electron population in a suitable target, such as Li, through irradiation with x rays generated by fast electrons traversing an electromagnetic field (as in a storage ring). Conditions to be satisfied by target and radiation parameters are stated, and examples given. (auth)

6076 Characteristic x-ray production by argon projectiles moving in graphite targets between 30 and 200 keV. Fortner, R.J.; Garcia, J.D. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., A;* 12: No. 3, 856-868(Sep 1975).

Thick-target yields and x-ray spectra have been measured for argon ions impinging on graphite targets at energies between 30 and 200 keV. The thick-target yields of carbon K-shell and argon L-shell x rays are analyzed on the basis of a simple model involving multiple collisions and molecular-orbital promotions. The analysis results in average argon L-shell fluorescence yields and total decay rates for argon ions traversing the solid. These values are found to be substantially lower than those appropriate to argon ions traversing a gas target. An explanation for the differences is proposed, and found to be corroborated by analysis of the observed x-ray spectra. An approximate determination of the argon M-shell vacancy distribution is obtained and compared with beam-foil charge equilibrium measurements.

6077 Energy straggling parameters from single event spectra. Wilson, W.E.; Toburen, L.H.; Glass, W.A. (Battelle Pacific Northwest Labs., Richland, WA). *Radiat. Res.;* 63: No. 3, 387-394(Sep 1975).

The variance of an energy straggling distribution for thin absorbers is determined by the cross section for energy loss in single collisions. The ratio, $delta_2$, of this variance and the mean energy loss is independent of the thickness of the absorber; it is also numerically equal to the quotient of the second by the first moment of the single collision spectra. Measured doubly differential cross sections for electron emission by energetic charged particles from low-Z molecular targets provide a major part of the primary data required for calculating $delta_2$. The relationship between $delta_2$ and experimentally measurable cross sections for single collision energy loss is developed. Values of $delta_2$ calculated from measured single collision cross sections are compared with values obtained from the free electron model and experiment. (auth)

6078 Local-field effects, x-ray diffraction, and the possibility of observing the optical Borrmann effect: solutions to Maxwell's equations in perfect crystals. Johnson, D.L. (Michelson Lab., China Lake, CA). *Phys. Rev., B;* 12: No. 8, 3428-3437(15 Oct 1975).

The electromagnetic normal-mode solutions to Maxwell's equations in perfect crystals are investigated including local-field effects by means of the dielectric-response matrix. The dynamical theory of x-ray diffraction is seen to be a special case thereof. At optical frequencies, a perturbation-theory expansion in q, the reduced wave vector, is solved and used to investigate the possibility that a microscopically varying component of the normal model, e/sup i(q Vector + K Vector).r Vector/ (K Vector is a reciprocal-lattice vector), can transmit into the vacuum. The optimal efficiency for this process is estimated to be 2.6×10^{-10} for $\hbar\omega = 1.5$ eV in diamond. However, this process may be affected by the intrinsic irregularities, on an atomic scale, of the crystal-vacuum interface. (auth)

MEDICAL PHYSICS

DOSIMETRY

6079 Calculations for high-energy radiations. Turner, J.E.; Wright, H.A.; Hamm, R.N. (Oak Ridge National Lab., Tenn. (USA)). *Radioprotection;* 9: No. 2, 131-140(1974).

The theoretical high-energy dosimetry program, developed over the past decade in the Health Physics Division of the Oak Ridge National Laboratory, is described briefly. Some selected results are presented to illustrate the calculational capabilities that exist. These examples include depth-dose curves for broad, parallel

beams of 2 GeV protons and 1 GeV neutrons incident laterally on a tissue slab and ^{11}C activation calculated as a function of depth in a water phantom exposed to a beam of 400 MeV neutrons. Because of their planned use in cancer radiotherapy research, pions are under extensive study. The Monte Carlo computer code, PION-I was developed to calculate the penetration of pions in materials (containing H, C, N, and O) exposed to pion beams. Good agreement is found between calculated and measured curves in water. Calculated L.E.T. distributions at various depths are shown. The pattern of energy deposition around pion capture sites is analyzed. T-1 kidney cell survival levels are predicted for pion beams based on data of Todd and on the survival model of Katz. (FR)

6080 Monte Carlo treatment of multiple Coulomb scattering in pion-beam dose calculations. Hamm, R.N.; Wright, H.A.; Turner, J.E. (Health Physics Division, Holifield National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **46**: No. 10, 4445-4452(Oct 1975).

Multiple scattering of negative pions in tissue is investigated by Monte Carlo methods for an 82-MeV pencil beam by using (i) single deflections of each pion at the target surface with straight trajectories thereafter, (ii) successive angular deflections after specified distances of travel in the target, and (iii) successive angular deflections and lateral displacements after specified distances of travel. Results of the computations are compared with results predicted by empirical formulas of Fowler and Perkins for depths of 14 and 18 cm. Method (ii), with a distance of 1 cm between successive deflections, appears to give a satisfactory representation of multiple scattering. A calculation of isodose contours for a sample pion beam is made both with and without multiple scattering. As this example shows, multiple Coulomb scattering severely limits the degree to which a concentrated therapeutic dose can be delivered to a localized tumor region.

SOLID STATE PHYSICS

6081 (AERE-R—8024) **Group theory and its applications to molecules and defects in solids.** Hughes, A.E. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Apr 1975. 100p. Dep. NTIS (US Sales Only) $6.00.

The application of the theory of crystal point groups to the properties of molecules and defects in solids is described. The first part of the text discusses the formal group theory required as a basis for applications in this field. It covers the basics of elementary group theory, the theory of representations, the properties of the thirty-two point groups and the incorporation of electron spin in the group formalism. The second part discusses application of the theory to the physical properties of crystals, crystal field theory, molecular orbitals, ligand field theory, vibrations and perturbation experiments (e.g. uniaxial stress and Zeeman effects). The use of irreducible tensor operators and time-reversal symmetry are also discussed. (auth)

6082 (CONF-750815—1) **Moessbauer relaxation lineshapes in the presence of hyperfine interactions containing off-diagonal terms.** Shenoy, G.K.; Dunlap, B.D. (Argonne National Lab., Ill. (USA)). Aug 1975. Contract W-31-109-Eng-38. 12p. Dep. NTIS $4.50.

From International conference on mossbauer spectroscopy; Cracow, Poland (Aug 1975).

The presence of off-diagonal terms makes the task of obtaining closed-form lineshape expressions difficult, if not impossible. This survey considers the superoperator formulation of the relaxation problem. The master equation obtained can be considerably simplified because the energy enters only along the diagonal as a constant. Then the "slave equation" can be used to obtain the lineshape over energy in a simple algebraic way. The calculation of spectral lineshapes in the presence of relaxation (spin, charge, or EFG -- electric field gradient) is rather straightforward using this formulation. Examples are taken from studies of heme compounds.(2 figures, 2 tables) (RWR)

6083 (IFA-SR—11-1974) **Program for optimal computation of E.P.R. spin Hamiltonian parameters for ions in tetragonal symmetry.** Sabba Stefanescu, A. (Institutul de Fizica Atomica, Bucharest (Romania)). 1974. 12p. INIS.

The program computes the EPR spin Hamiltonian parameters for paramagnetic ions in a tetragonal environment, in an external magnetic field H. Its purpose is to optimize this computation with respect to the experimental error. (auth)

6084 (SAND—75-5752) **Series studies of critical exponents in continuous dimensions.** Van Dyke, J.P.; Camp, W.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 8p. (CONF-751209—3). Dep. NTIS $4.50.

From 21. annual conference on magnetism and magnetic materials; Philadelphia, Pennsylvania, USA (9 Dec 1975).

Through use of results previously derived for the high-temperature susceptibility expansion of classical models as a closed-form function of lattice dimension, a study is made of the dimensional dependence of the critical exponent γ and critical temperature, as well as the correction-to-scaling exponent Δ_1, for Ising-like (n = 1) models. The numerical results are obtained by extrapolation of 10-th order series on loose-packed hypercubical lattices and 8-th order series on close-packed hypertriangular lattices. The critical exponent γ increases monotonically with decreasing dimension, d, for $d < 4$, and apparently tends to infinity at $d = 1$; while the critical temperature decreases monotonically and smoothly to zero at $d = 1$. Detailed contact is made with the ϵ-expansion estimates for critical exponents obtained in the context of renormalization group theory. (1 figure, 1 table) (auth)

6085 New algorithm for Monte Carlo simulation of Ising spin systems. Boritz, A.B. (Yeshiva Univ., New York); Kalos, M.H.; Lebowitz, J.L. *J. Comput. Phys.;* **17**: No. 1, 10-18(Jan 1975).

A new algorithm for Monte Carlo simulation of Ising spin systems is described, and results of a study comparing the speed of the new technique to that of a standard technique applied to a square lattice of 6400 spins evolving via single spin flips are presented. At temperatures T less than T/sub c/, the critical temperature, the new technique is faster than the standard technique, being ten times faster at T = 0.588 T/sub c/. The new technique is expected to be especially valuable in Monte Carlo simulation of the time evolution of binary alloy systems. The new algorithm is essentially a reorganization of the standard algorithm. It accounts for the a priori probability of changing spins before, rather than after, choosing the spin or spins to change. 2 tables (auth)

6086 Course in applied solid state physics. Dalven, R. (Univ. of California, Berkeley). *Am. J. Phys.;* **43**: No. 4, 364-365(Apr 1975).

A course in applied solid state physics given in the Department of Physics of the University of California at Berkeley is briefly described. The course was a one-quarter series of about 30 lectures designed to be a sequel to the usual one- or two-quarter course in solid state physics taken by many physics students. The course was designed to be a survey of the physics of a variety of solid-state devices. 1 table (RWR)

6087 High-temperature series for the susceptibility of the spin-s Ising model: analysis of confluent singularities. Camp, W.J.; Van Dyke, J.P. (Sandia Labs., Albuquerque, NM). *Phys. Rev., B;* **11**: No. 7, 2579-2596(1 Apr 1975).

The series for the zero-field susceptibility of the spin-s Ising model was extended through tenth order in the reduced inverse temperature K on the square, triangular, simple-cubic, body-centered-cubic, and face-centered-cubic lattices. The series coefficients h/sub n/(s) are expressed as simple polynomials in X = s (s + 1). Using extended methods of analysis the nature of the leading singularities on the face-centered lattice were estimated and it is concluded with good confidence that the susceptibility exponent $\gamma_1 = 1.25$, independent of s. The exponent of the leading correction term is estimated to be γ_2 approximately equal to 0.75 +- 0.08 in good agreement with renormalization-group theory. For $s = 1/2$ only, the amplitude of the confluent correction apparently vanishes. The leading singularities on the triangular lattice were also studied and it is concluded that $\gamma_1 = 7/4$, independent of s, with, however, much stronger corrections than in three dimensions. These results provide a very strong corroboration of the universality hypothesis. (auth)

6088 Stationary nonequilibrium properties of a quantum-mechanical lattice with self-consistent reservoirs. Visscher, W.M.; Rich, M. (Los Alamos Scientific Lab., NM). *Phys. Rev., A;* **12**: No. 2, 675-680(Aug 1975).

The self-consistent reservoir (SCR) model of lattice thermal conductivity is combined with the quantum Langevin equation formulation of Ford, Kac, and Mazur to obtain a quantum SCR model for lattice conductivity. Application is made to simple cubic monatomic lattices with harmonic nearest-neighbor interactions. A general expression for the thermal conductivity is obtained, and its high- and low-temperature limits examined. (auth)

6089 Hohenberg—Kohn theorem for nonlocal external potentials. Gilbert, T.L. (Argonne National Lab., IL). *Phys. Rev., B;* **12**: No. 6, 2111-2120(15 Sep 1975).

The Hohenberg-Kohn theorem is extended to the case that the external potential is nonlocal. It is shown that, in this more general case, a nondegenerate ground-state wave function is a universal functional of the one-particle density kernel $\mu(x,x')$, but probably not of the particle density n(r vector) = Σ/sub s/μ n(r vector s,r vector s). The variational equations for the local and

nonlocal cases are compared. The former must be replaced by a variational equation for an equivalent system of noninteracting particles, following a prescription of Kohn and Sham, in order to obtain a Schroedinger-like form, and contains only local potentials. The latter may be obtained directly in Schroedinger-like form, but the exchange-correlation potential is nonlocal. If the nonlocal pseudo-Hamiltonian exists [i.e., if the functional derivative delta E/delta $\mu(x,x')$ exists for a nondegenerate ground-state density kernel], then the eigenfunctions of the pseudo-Hamiltonian are natural spin orbitals, and all partially occupied orbitals (0 less than [phi/sub i/parallel bar μ parallel bar phi/sub i/] less than 1) belong to the same degenerate eigenvalue of the pseudo-Hamiltonian. Finally, it is shown, as a corollary of Coleman's theorem for N-representable density kernels, that any finite non-negative differentiable function is an N-representable particle density. (auth)

6090 Energy transfer in one-dimensional molecular crystals: direct and indirect energy exchange in the non-Boltzmann regime. Lewellyn, M.T.; Zewail, A.H.; Harris, C.B. (Department of Chemistry and Inorganic Materials Research Division of Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.*; **63**: No. 9, 3687-3693(1 Nov 1975).

Direct energy transfer between localized states via virtual coupling with the host states in one-dimensional molecular solids is demonstrated experimentally using optical and optically detected electron spin coherence techniques. The relative importance of direct transfer versus indirect transfer (which is characterized by the phonon-assisted promotion of the localized state to the band with the subsequent radiationless decay into a mobile exciton followed by retrapping) has been determined in isotopically mixed 1,2,4,5-tetrachlorobenzene crystals over a temperature range where the thermal energy of the lattice is insufficient to establish Boltzmann equilibria between the localized and delocalized states (non-Boltzmann regime). The results demonstrate that the transfer mechanisms between trap and host states are very sensitive to the trap concentration and the temperature of the lattice, and that direct exchange is dominant at high trap concentrations. Finally, the experimental results are compared with the theoretical expectations for excitation yields and trap-to-trap distances in the isotopically mixed crystals. (AIP)

SUPERCONDUCTIVITY

6091 (COO—1569-132) **Experimental studies in solid state and low temperature physics. Progress report, 1975.** Goldman, A.M.; Weyhmann, W.V.; Zimmermann, W. Jr. (Minnesota Univ., Minneapolis (USA). School of Physics). Sep 1975. Contract E(11-1)-1569. 27p. Dep. NTIS $5.00.

Experimental investigations are being carried out in a broad area of low-temperature and solid-state physics which includes superconductivity, magnetism in metals and liquid and solid helium. The pair-field susceptibility of superconductors is being studied. A propagating mode in the phase of the superconducting order parameter has been found. Heat capacities of superconducting films in the vicinity of T/sub c/ are also being investigated. An investigation in the time-dependent high conductivity of dilute solid solutions of sodium in ammonia has been initiated. Nuclear orientation studies of the dilute magnetic impurity problem in metals in the 1 mK temperature region are being carried out. Refrigeration requirements for this work are being met using enhanced hyperfine nuclear cooling. Measurements of the differential osmotic pressure of ^{3}He/^{4}He liquid mixtures near the tricritical point have shown a peak in the "concentration susceptibility" at the lambda line. Data obey a simple tricritical scaling relation. The dynamics of superfluid flow through submicron pores are being studied in both pure ^{4}He and in ^{3}He/^{4}He mixtures in an apparatus provided with a ^{3}He refrigerator. The quantization of circulation in superfluid liquid ^{4}He is being investigated using the Vinen method. The low temperature heat capacity of bcc solid ^{3}He is being studied. (auth)

GENERAL THEORY

6092 Electronic properties of polymeric sulfur nitride. Schluter, M.; Chelikowsky, J.R.; Cohen, M.L. (Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev. Lett.*; **35**: No. 13, 869-872(29 Sep 1975).

We present a three-dimensional band-structure calculation of (SN)/subx/ using the empirical pseudopotential scheme. The density of states, Fermi surface, and optical spectrum are calculated. Estimates for the electron-phonon coupling constant λ are given and the increase of T/subc/ with pressure is discussed. The assumption of an electron-phonon mechanism for superconductivity in (SN)/subx/ is consistent with our results.

6093 Localized description of superconductivity. II. Strong-coupling formulation. Birnboim, A.; Gutfreund, H. (The Racah Institute of Physics, The Hebrew University of Jerusalem, Jerusalem, Israel). *Phys. Rev., B;* **12**: No. 7, 2682-2689(1 Oct 1975).

A localized description of superconductivity in narrow-band metals, proposed by Appel and Kohn, is extended to the strong-coupling case. Equations similar, but not identical, to the Eliashberg equations are obtained. These equations are solved numerically and the results are represented by a semiphenomenological formula for T/subc/. A microscopic calculation of the electron-phonon coupling constant in the localized representation, based on measured phonon frequency-distribution curves and augmented-plane-wave band calculations, is described. Results for V, Nb, and Ta yield values of λ within a factor of 2 from the expected ones, without any adjustable parameter.

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

6094 (COO—2314-7) **Temperature dependence of contact potential in superconducting niobium.** Pipes, P.B.; Darling, D.H. (Dartmouth Coll., Hanover, N.H. (USA). Dept. of Physics and Astronomy). 1975. 4p. (CONF-750827—3). Dep. NTIS $4.50.

From Conference on decontamination and decommissioning of ERDA facilities; Idaho Falls, Idaho, USA (19 Aug 1975).

For a superconductor in a stationary condition, it can be shown that a gradient in the chemical potential is balanced by a gradient in the internal electrostatic potential. An attempt has been made to measure these electrostatic effects directly for niobium by measuring the temperature derivative of the contact potential as a function of temperature. (1 figure) (SDF)

6095 (LA-tr—75-27) **Short communication on the connection between transition temperature and critical current density of superconducting wires on the basis of intermetallic phases of the β-W type.** Rassmann, G.; Muller, P. Translated from *J. Less-Common Met.*; **39**: 335-339(1975). 9p. Dep. NTIS $4.00.

The effect of structure and structure defects on T/sub c/ and j/sub c/ was theoretically considered. The relation between T/sub c/ and j/sub c/ was experimentally tested on powder-metallurgy prepared compacts of Nb_3Sn, Nb_3Al, and $Nb_3(Al,Ge)$. The results obtained in the measurement of the critical current in a field of 40 kA/cm and a measurement temperature of 4.2°K as a function of T/sub c/(T/sub c/ = T_0 - T/sub c/) were graphed and compared with results obtained by other investigators. (JSR)

6096 The anisotropy of H/subc/2 and its implications to grain-boundary flux pinning in V_3Si. Kramer, E.J.; Knapp, G.S. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.*; **46**: No. 10, 4595-4596(Oct 1975).

It is reported that V_3Si has an extremely large anisotropy in H/subc/2. This anisotropy is large enough to account for the observed strength of grain-boundary pinning observed in polycrystalline V_3Si.

6097 Acoustic coupling of thin superconducting films. Schuller, I.; Gray, K.E. (Solid State Science Division, Argonne National Laboratory, Argonne, Illinois 60439 and Physics Department, Northwestern University, Evanston, Illinois 60201). *Phys. Rev., B;* **12**: No. 7, 2629-2633(1 Oct 1975).

The acoustical coupling of two thin superconducting films forming a tunnel junction was measured. The experiment was performed by photoexciting quasiparticles in one film and studying the resulting change in the energy gaps. The results show that the phonon escape parameter from lead to tin agrees with calculated values and there is an indication of an additional escape mechanism in the lead films.

THEORETICAL PHYSICS

GENERAL AND MISCELLANEOUS

6098 (COO—2271-60) **Examples of four-dimensional soliton solutions and abnormal nuclear states.** Lee, T.D. (Columbia Univ., New York (USA); European Organization for Nuclear Research, Geneva (Switzerland)). 1975. 8p. (CONF-750695—3). Dep. NTIS $4.50.

From Conference on extended systems in field theory; Paris, France (26 Jun 1975).

The classical soliton solution is defined to be one that (1) has finite and nonzero rest mass, and (2) is contained in a finite region in space. Starting with a relativistic boson field with nonlinear coupling, four dimensional quantum soliton solutions are discussed by considering the classical solution and then quantizing it by a general canonical procedure. Remarks are then given on

the generalization of the soliton mechanism to include fermions, leading to abnormal nuclear states. (SDF)

CLASSICAL AND QUANTUM MECHANICS

6099 (ORO—4856-21) **Constraints in quantum mechanics via Lagrangians, Hamiltonians, and Canonical equations of motion.** Amiot, P.; Griffin, J.J. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). [nd]. 24p. Dep. NTIS $4.50.

A general method of derivation of the auxiliary constrained Hamiltonian describing a constrained system is proposed. The introduction of the constraint operator into the Lagrangian leads, for holonomic constraints, to a simple definition of the auxiliary Hamiltonian by a unitary transformation on the unconstrained Hamiltonian. This gives immediately the constrained parametrized wave function once the unconstrained one is known. This method which gives results different from other methods, is designed to calculate collective kinetic energy terms of the Hamiltonian describing collective motions of N-body systems, but offers, in addition, the promise of further development towards a complete, general theory of collective motion. (auth)

RELATIVITY AND GRAVITATION

6100 (ORO—240) **Tachyons and cosmology.** Sudarshan, E.C.G.; Narlikar, J.V. (Texas Univ., Austin (USA). Center for Particle Theory). Nov 1975. Contract AT(40-1)-3992. 31p. Dep. NTIS $5.00.

The propagation of tachyons in an expanding universe is discussed. It is shown that a primordial tachyon in the big bang universe cannot survive unless it had very large energy initially. In an indefinitely expanding universe the tachyon trajectory turns back in time. This time barrier is found to exist even in the quantum mechanical discussion of tachyons. This property is used to set limits on the mass of a tachyon. The possible astronomical checks on the hypothesis that neutrinos or photons may be tachyonic are also discussed. (auth)

6101 **Generalizations of Bremmer series solutions of wave equations.** Bellman, R.; Vasudevan, R. (Univ. of Southern California, Los Angeles). *J. Math. Anal. Appl.;* **52**: No. 1, 151-167(Oct 1975).

The scalar wave equation with an inhomogeneous source term is studied, and solutions corresponding to different initial eikonal approximations of the wave solution are analyzed. Different orders of approximations lead to the different types of generalizations. A unified picture of the several methods of generalization of the WKB method emerges. It is found that an approximation to the eikonal achieved by the quasilinearization technique turns out to be a fruitful method. (JFP)

ACOUSTICS

6102 **Status and future of nonlinear acoustics.** Westervelt, P.J. (Brown Univ., Providence). *J. Acoust. Soc. Am.;* **57**: No. 6, 1352-1356(Jun 1975).

In addition to serving as an ideal discipline for introducing the concepts of quantum field theory and general relativity, nonlinear acoustics provides a new means for absorbing and generating sound. The many applications of this exciting subject are based in part on the fact that, in common with vector (electromagnetic and shear) and tensor (gravitational) waves, the scalar sound wave transports energy, angular momentum, linear momentum, and, incidentally, information. The methods of nonlinear acoustics can account for such disparate phenomena as the parametric array and the radar time delay in a gravitational field; the absorption of sound in superfluid helium and shock-wave attenuation in a gas; radiation pressure and sonic boom; the scattering of sound by sound; and the generation of gravitational waves. Based on the ability of nonlinear acoustics to subsume within its methodology, and hence to unify, different physical processes, as well as its demonstrated ability to contribute solutions to practical problems, it seems reasonable to expect that this subject will become a part of the curriculum in more colleges and universities than is the case at present. 6 figures (auth)

OPTICS

6103 (LBL—4180) **Nonlinear optics in a one-dimensional periodic medium.** Sehn, Y.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-ENG-48. 18p. (CONF-7506104—1). Dep. NTIS $4.50.

From Proceedings on nonlinear optical spectroscopy; Varenna, Italy (30 Jun 1975).

Simple nonlinear optical effects in a medium with a superlattice are discussed. Cholesteric liquid crystals are emphasized. (2 figures, 1 table) (RWR)

6104 (UCRL—51847) **LITEPATH: a computer code to simulate an optical system.** Yaffe, L.G.; Mode, V.A.; Sisson, D.H.; McMillan, G.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Nov 1975. Contract W-7405-Eng-48. 22p. Dep. NTIS $4.50.

A computer code to simulate a general spectroscopic optical system was written. The user has the freedom to construct essentially any arrangement of optical surfaces between a light source and a detector. The source may be a point source, or an emitting volume with a linear or nonlinear intensity profile. The optical surfaces may absorb, reflect, refract, filter, or transmit photons. With this code, it was possible to calculate instrument correction factors for actual fluorescence systems and to verify the model with experimental results. A listing of the source code and two support programs are included. (7 figures, 3 tables) (auth)

6105 **Calculation of the fractional order number at the center of a Fabry—Perot interferometer-fringe system.** Steinhaus, D.W. (Los Alamos Scientific Lab., NM); Kline, J.V. *J. Opt. Soc. Am.;* **65**: No. 7, 814-816(Jul 1975).

With the traditional least-squares-calculation procedure, some measurements have great influence on the calculated fractional order number, whereas others contribute nothing to the final value. This is very unfortunate for the experimentalist, who would like to make full use of each measured value. To obtain the desired equal influence, the calculation procedure must be modified to use a fixed value of $\Delta(R^2)$. This fixed value may come from the average of many adjacent spectral lines. Use of the modified procedure results in much greater precision without increasing the measurement effort. 4 figures. (auth)

STATISTICAL PHYSICS AND THERMODYNAMICS

6106 (FRNC-TH—540) **Theoretical study of a weakly ionized gas in a uniform constant electric field.** Segur, P. (Toulouse-3 Univ., 31 (France)). 1974. 260p. (In French). INIS.

Thesis.

The collision operators of the Boltzmann equation are expressed in terms of the transition probabilities for a Lorentz gas and inelastic type collisions in the case of conservation and nonconservation of the initial number of particles. These operators are approximately expressed when the mass ratio of the present particles is weak. The expressions obtained are valid for any particle distribution functions. A series expansion in spherical harmonics is effected for these operators. The Boltzmann equation is then solved for the case of a steady homogeneous medium when the electric field effect is lower than that of collisions. A resolving method is then proposed for the case where the electric field and collisions play comparable roles. Analytical expressions are given for the distribution functions in terms of asymptotic solutions valid for any type of cross section. A steady heterogenous medium is then studied by a direct numerical solution of the Boltzmann equation, for high values of the electric field/pressure ratio. The existence of a single lattice of characteristic directions is established as well as a distribution function representing in phase space a band structure characteristic of the presence of inelastic collisions. The electron motion is simulated using a Monte-Carlo method. The calculations being effected in helium, a bibliography of the cross sections for this gas is given. (FR)

6107 (UCID—16901) **New EOS for air.** Graboske, H.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Sep 1975. Contract W-7405-ENG-48. 23p. Dep. NTIS $4.00.

A new air EOS has been developed for LLL hydrocode use. It accurately reproduces the detailed NBS ideal gas dissociation-ionization physics currently used as the tabular air EOS, over those rho, T regions where this approximation is valid. For higher densities and both lower and higher temperatures, it includes dense molecular and atomic interactions, the dense partially ionized coulomb plasma, and the very dense metallic coulomb fluid. The new EOS covers the range 10^{-7} less than or equal to rho (g/cm) less than or equal to 15 and 0.015 less than or equal to T(eV) less than or equal to 3×10^4. (auth)

6108 **Melting and its relation to molecular orientations in the fluid and solid phases of N_2 and CH_4.** Crawford, R.K. (Univ. of Illinois, Urbana); Daniels, W.B.; Cheng, V.M. *Phys. Rev., A;* **12**: No. 4, 1690-1696(Oct 1975).

A comparison of recent melting data for N_2, CH_4, and Ar suggests that there probably is greater local orientational order in the dense fluid phases of N_2 and CH_4 than in their respective solids near melting. The possible nature of this local orientational order is discussed. (auth)

MATHEMATICAL PHYSICS

6109 **Wick rotation.** O'Brien, D.M. (Univ. of Adelaide). *Aust. J. Phys.*; **28**: No. 1, 7-13(Feb 1975).

A justification is presented for the use of the Wick rotation in the construction of solutions to Wick's equation. This is done by demonstrating the equivalence of the solutions found by Wick (1954) and by Green (1957) with and without recourse to the Wick rotation respectively. (auth)

6110 **Heat conduction model with finite signal speed.** DeFacio, B. (Los Alamos Scientific Lab., NM). *J. Math. Phys. (N.Y.)*; **16**: No. 4, 971-974(Apr 1975).

A simple physical model is derived which has a finite signal speed for a heat pulse in a linear medium. The most general E^2 invariant constitutive equation for energy flux epsilon which allows the finite signal speed is given. The assumptions which are required include continuum mechanics, thermodynamics of adiabatic processes, and a generalized Fourier heat law for the energy flux epsilon. Then singular perturbation theory with the finite signal speed u^{-1} as a parameter is used to reduce the hyperbolic heat equation to the usual parabolic heat conduction equation. (auth)

CONTROLLED THERMONUCLEAR RESEARCH

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

6111 (CONF-751125—65) **Some physics considerations for TEPR designs.** Hogan, J.T.; Rome, J.A.; McAlees, D.G.; Attenberger, S.E. (Oak Ridge National Lab., Tenn. (USA)). 1975. 5p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A simplified version of the Oak Ridge Tokamak Transport Code is used to assess the implications of confinement scaling, impurity trapping of neutral beam particles and plasma currents driven by neutral injection. The ORNL, ANL and GAC experimental power reactor reference designs are considered. (auth)

6112 (LA-UR—75-857) **Implosion and staging systems for a scyllac fusion test reactor.** Gribble, R.F.; Linford, R.K.; Thomassen, K.I. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 4p. (CONF-741178—2). Dep. NTIS $4.00.

From Conference on energy storage, compression and switching; Torino, Italy (5 Nov 1974).

The implosion heating and adiabatic compression processes will be separated in future theta pinch devices. The circuit to achieve the fast implosion heating and power crowbar (staging) for the Scyllac Fusion Test Reactor is described here. The plasma is very tightly coupled to the circuit and presents a varying inductive load. Computer-aided circuit designs which achieve a programmed magnetic field waveform are described. The field approximates a two-step waveform, on-off-on, which is ideal for achieving the large initial plasma radius needed for stability. The components for the circuits have been developed and are being tested in experiments at Los Alamos. (auth)

6113 (MATT—1140) **Wave generation and heating near ion cyclotron frequency in the ST Tokamak.** Takahashi, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 33p. Dep. NTIS $4.00.

The results of the recent, high power ICRH experiments performed on the ST Tokamak are reported. It was demonstrated that both the fast and slow waves could be generated in toroidal geometry, and heating of the plasma ions at power levels up to 1 MW was observed both at the ion cyclotron frequency (ω/sub ci/) and its second harmonic (2ω/sub ci/). Measurements by a charge exchange neutral detector directed tangentially to the plasma torus revealed that at 2ω/sub ci/ the ion energy within the bulk of the ion distribution function ("parallel body temperature") could be increased from about 100 eV up to 200 eV with efficiencies ranging from 8 to 45 percent. Efficiency at ω/sub ci/ in raising the parallel temperature was less than at 2ω/sub ci/. Charge exchange neutral detection perpendicular to the plasma column showed that both at ω/sub ci/ and 2ω/sub ci/ the "perpendicular body temperature" was enhanced very rapidly by a factor of up to 3. Also, build-up of a high energy "tail" in the ion energy distribution was observed. Power transfer to the ions seemed extremely efficient. (auth)

6114 (TID—26910) **Neutral-beam control study, Phase 1. Final report.** (Draper (Charles Stark) Lab., Inc., Cambridge, Mass. (USA)). Nov 1975. Contract AT(11-1)-2572. 49p. Dep. NTIS $5.00.

This report describes investigations into the technical and operational elements of the control of multiple neutral-beam injectors in experimental systems. In particular, a heuristic model of the source behavior during conditioning operations is developed and used as a basis for control-loop development. The control-loop components, various estimators, and control laws are developed, and a formal control strategy utilizing these components is defined. (auth)

6115 (UCRL—77079) **Experimental determination of DT ion temperatures in laser fusion targets.** Ahlstrom, H.G.; Slivinsky, V.W.; Tirsell, K.G.; Storm, E.K.; Glaros, S.S.; Campbell, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Oct 1975. 18p. (CONF-751130—1). Dep. NTIS $4.00.

From APS meeting; St. Petersburg, Florida, USA (10 Nov 1975).

Using the time-of-flight technique, energy distribution measurements were made of the fusion produced α particles emitted from laser implosions of DT gas contained in glass microshells. The number of nuclear reactions was determined by an absolute measurement of both the number of α particles and the number of neutrons. From the FWHM of the α particle energy distributions, upper limits of the plasmas ion temperature have been inferred. By applying corrections for the broadening of the distribution due to the fuel and the pusher, ion temperatures of 2-3 keV have been calculated. These measurements constitute significant evidence that the implosions produced thermonuclear burn of the DT fuel. (auth)

6116 **Applications of intense relativistic electron beams to controlled thermonuclear fusion.** Sudan, R.N. (Cornell Univ., Ithaca, NY). pp 184-199 of In Sixth European conference on controlled fusion and plasma physics. Vol. II. Dubna, USSR; Joint Inst. for Nuclear Research (1974).

From 6. European conference on controlled fusion and plasma physics; Moscow, USSR (30 Jul 1973).

See CONF-730705—P2.

The heating of magnetically confined plasma by intense relativistic electron beams is discussed in terms of two-stream instability heating and high-density plasma heating. Beam focusing for solid-target heating is described along with magnetic field shaping and electromagnetic and MHD instabilities. (MOW)

6117 **Diffusion of multicomponent plasmas in axisymmetric tokamaks.** El-Derini, Z.M.H. Madison, WI; Univ. of Wisconsin (1975). 131p. University Microfilms Order No.75-16,309.

Thesis (Ph. D.).

The diffusion of impurities as well as alpha particles was analyzed in detail for both cylindrical and axisymmetric tokamaks in the banana regime. An estimate of the different species fluxes shows that with sufficient accumulation of an impurity the diffusion rate of the low Z ions is (m/sub i//m/sub e/)/sup 1/2/ greater than that of a simple plasma. This result is due to the friction between the different ion components of the plasma. The diffusion fluxes also show that the ions with higher charge will be concentrated in the center of the plasma while the lower Z ions will diffuse out. A sufficiently strong negative temperature gradient can reverse this effect. (Diss. Abstr. Int., B)

6118 (ERDA-tr—68) **Energy balance in large installations of "Tokamak" type.** Dnestrovskii, Yu.N.; Kostomarov, D.P.; Lysenko, S.E. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1975. Translation of IAE—2494. 43p. Dep. NTIS $4.00.

On the basis of one-dimensional equations of the energy balance, an analysis is made of the heating of plasma in large installations of the Tokamak type of the eightieth generation. Typical dimensions of the examined installations are: R = 400 cm, a = 150 cm. "Pseudoclassical" and "Bomov" models of thermal conductivity are used in the computations. Heating of plasma is taken into account with the aid of injection of a beam of fast neutral particles, cooled by an influx of cold neutral particles from vacuum, transfer of energy of α-particles to the plasma, and cyclotron radiation and bremsstrahlung. (auth)

6119 **Control of re-cycling and impurities in the ATC Tokamak by means of gettered surfaces.** Stott, P.E.; Daughney, C.C.; Ellis, R.A. Jr. (Princeton Univ., NJ). Contract AT(11-1)-3073. *Nucl. Fusion*; **15**: No. 3, 431-439(Jun 1975).

6120 **Effect of impurities on lower hybrid heating of a toroidal hydrogen plasma.** Kritz, H. (Hunter Coll., New York); Elridge, O. *Nucl. Fusion*; **15**: No. 3, 465-470(Jun 1975).

PLASMA DIAGNOSTICS

6121 (COO—2180-5) **Microwave measurements of electron density in a spherical inertial-electrostatic confinement system using six ion guns.** Chan, A.I.Y. (Brigham Young Univ., Provo, Utah (USA)). Aug 1975. Contract AT(11-1)-2180. 145p. Dep. NTIS $7.00.

The electron density in a spherical inertial-electrostatic confinement device using six ion beams was studied with microwave techniques involving the fundamental and higher order cavity resonances. Thermal expansion problems were circumvented by switched operation of the device. The deuterium background pressure was found to be a dominant factor in determining n/sub e/ throughout the entire range of 0.4 to 10 milliTorr. With 1 m Torr pressure and 10 mA total ion current (at 20 to 40 keV) central electron densities of the order of 10^9 electrons/ cm^3 were estimated, with total population of approximately 10^{10} electrons. No evidence of shell structure of the electron density was found, although the use of higher order modes to obtain better spatial resolution was precluded by the low magnitude of n/sub e/. Indirect indication of weak ion trapping was obtained by measurement of the enhancement of neutron flux that resulted when the guns were operated simultaneously. (auth)

6122 (COO—2180-6) **Measurements of neutron flux from an inertial-electrostatic confinement device.** Westenskow, G.A. (Brigham Young Univ., Provo, Utah (USA)). Aug 1975. Contract AT(11-1)-2180. 50p. Dep. NTIS $5.00.

A neutron-detection system was built for the purpose of measuring the neutron flux from an Inertial-Electrostatic Confinement Device located at Brigham Young University. A BF_3 proportional counter was used for absolute flux measurements and a pair of scintillation detectors was used to compare neutron output under different operating conditions. The detectors were designed to be compatible with the operating conditions of the device and to be able to measure small changes in neutron output. The detectors were calibrated using a Pu-Be source with corrections made for laboratory conditions. Performance of the counting system was checked and data were collected on the neutron flux from the device. (auth)

6123 (LA-UR—75-1344) **X-ray diagnostics in the laser-initiated fusion program.** Godwin, R.P. (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1975. Contract W-7405-Eng-36. 58p. (CONF-750831—1;). Dep. NTIS $6.00.

From 24. annual conference on applications of x-ray analysis; Denver, Colorado, USA (6 Aug 1975).

The high-density and high-temperature plasma conditions required for successful laser-initiated fusion make x-ray diagnostics a valuable tool in this exciting field. Measurements of the hard x-ray continuum emitted from laser targets provide insight into the complex laser-plasma coupling physics and the consequent energy transport through the bremsstrahlung signature of energetic electrons. X-ray techniques are important in the selection and assay of microballoon targets for current compression experiments. X-ray imaging experiments and diffraction spectroscopy of highly stripped atoms can provide information upon the symmetry, density and temperature of laser targets. Extremely high temporal and spatial resolution may be required for definitive diagnostic information on compressed targets. While laser-produced plasmas are interesting as possible intense x-ray sources and as a possible means of achieving x-ray lasing, those topics are outside the scope of this review. (auth)

6124 (LA-UR—75-1491) **Implosion measurements in a high voltage, large diameter, medium density theta pinch.** Henins, I.; Hammel, J.E.; Jarboe, T.E.; Marshall, J.; Sherwood, A.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 5p. (CONF-750944—5). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Extensive sets of density measurements were obtained for two preionization levels with other parameters held constant ($B = 0.5$ T, $n_o = 4.8 \times 10^{14}$ cm^{-3}, E/sub theta/ = 1 kV/cm). The gross features of the implosion are similar in the two cases, but the density front is double-peaked for the higher preionization case. Generally, the particles move ahead of the driving magnetic field front, but some are also within this front. After reaching the axis the imploding plasma is observed to move outward again through the magnetic field in a manner suggesting anomalous transport. The particles stop at the outer radii. The total number of particles increases during the implosion and thereafter remains about constant. (auth)

6125 (LA-UR—75-1519) **Optical diagnostics on scyllac.** Freese, K.B.; Jahoda, F.C.; Kristal, R.; Seibel, F.T.; Siemon, R.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-750944—17). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The Scyllac toroidal theta pinch optical diagnostic complement consists of three types of measurements: plasma self-luminosity, laser interferometry, and laser light scattering. Each is described separately below. (auth)

6126 (MATT—1150) **Observations of internal relaxation oscillations in the adiabatic toroidal compressor.** Smith, R.R. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 17p. Dep. NTIS $4.00.

The soft x ray signal from the Adiabatic Toroidal compressor (ATC) sometimes exhibits a 10 percent modulation with a frequency between 1 and 2 Kilohertz. The radial profile of the soft x ray signal and the electron temperature determined by laser scattering indicate that these fluctuations are associated with a limitation of the central electron temperature and a broadening of the temperature profile. By observing changes in the radial dependence of the relaxation oscillation during neutral injection, an increase of thirty to fifty percent in the radius where $q = 1$ was measured. (auth)

6127 (ORNL-TM—5022) **Hard x-ray detection system for ORMAK.** Knoepfel, H.E.; Renk, T.; Zweben, S. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 31p. Dep. NTIS $4.00.

Some of the basic problems connected with the measurements of hard bremsstrahlung, as they appear in following the x-ray from the target to the detector and beyond, are described. Finally, procedures are presented for unfolding experimental (scintillation) spectra into the original electron distribution function. (MOW)

6128 (UCRL—77247) **Ultra-fast image converter streak cameras for laser fusion diagnostics.** Houghton, J.W.; Thomas, S.W.; Attwood, D.T.; Coleman, L.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Nov 1975. Contract W-7405-Eng-48. 6p. (CONF-751125—21). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The design and operation of a 10-ps resolution optical streak camera used to characterize laser pulses and other transient optical signals in fusion research is discussed. Performance characteristics are presented. The design, operation, and application of an x-ray streak camera used to study laser-produced plasmas in the x-ray spectral region of 1 to 10 keV with temporal and spatial resolutions of approximately 20 ps and approximately 10 μm is also discussed. (auth)

6129 (UCRL—77478) **Microprocessor system to recover data from a self-scanning photodiode array.** Koppel, L.N.; Gadd, T.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Nov 1975. Contract W-7405-Eng-48. 7p. (CONF-751116—5). Dep. NTIS $4.50.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

A microprocessor system developed at Lawrence Livermore Laboratory has expedited the recovery of data describing the low energy x-ray spectra radiated by laser-fusion targets. An Intel microprocessor controls the digitization and scanning of the data stream of an x-ray-sensitive self-scanning photodiode array incorporated in a crystal diffraction spectrometer. (auth)

6130 (UCRL—77504) **2XIIB computer data acquisition system.** Tyler, G.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Nov 1975. 15p. (CONF-751125—16). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

All major plasma diagnostic measurements from the 2XIIB experiment are recorded, digitized, and stored by the computer data acquisition system. The raw data is then examined, correlated, reduced, and useful portions are quickly retrieved which direct the future conduct of the plasma experiment. This is done in real time and on line while the data is current. The immediate availability of this pertinent data has accelerated the rate at which the 2XII personnel have been able to gain knowledge in the study of plasma containment and fusion interaction. The up time of the experiment is being used much more effectively than ever before. This paper describes the hardware configuration of our data system in relation to various plasma parameters measured, the advantages of powerful software routines to reduce and correlate the data, the present plans for expansion of the system, and the problems we have had to overcome in certain areas to meet our original goals. (auth)

6131 Thomson-scattering density measurements in 2XII at low magnetic guide fields. Simonen, T.C. (Lawrence Livermore Lab., CA). *Nucl. Fusion;* 15: No. 3, 542-543(Jun 1975).

6132 Subnanosecond time resolution detection of x-ray pulses using chemical dosimetry. Harney, R.C. (Lawrence Livermore Laboratory and Department of Applied Science, University of California, Davis-Livermore, Livermore, California 94550). *J. Appl. Phys.;* 46: No. 10, 4453-4457(Oct 1975).

The possibility of using chemical dosimetry to detect x-ray pulses with subnanosecond time resolution is theoretically investigated. The theory of chemical dosimetry is reviewed and a dosimeter consisting of a laser, an absorption cell, and an ultrafast optical streaking camera is analyzed. This analysis indicates that time resolutions of less than 100 psec are achievable at x-ray energies greater than 4 keV. Predicted threshold dose rates are low enough (1—3) times10^{13} rad sec^{-1} so that the technique should be applicable to diagnostics of x-ray lasers, laser-produced x-ray experiments, and laser fusion experiments. Effects of photon energy, x-ray—induced solvent heating, high-Z doping of the solvent, cell length, and laser wavelength are discussed.

PLASMA KINETICS - GENERAL

6133 (MATT—1174) **Conference report for nuclear fusion phenomena in ionized gases.** Porkolab, M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 14p. Dep. NTIS $4.00.

A summary of the Conference on Phenomena in Ionized Gases, held in Eindhoven, The Netherlands, is given. In particular, the format of the conference and the content of the review papers are summarized. (auth)

6134 (SAND—75-5747) **Z/sub e/ lt 1OMEGA pinched electron diodes.** Poukey, J.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 9p. (CONF-751108—2). Dep. NTIS $4.50.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

High current pinched electron flow in diodes is shown to be self-limiting, in the sense that for given diode voltage the electron current approaches a limiting value as R/d (cathode radius/gap)yields infinity. The consequence is that in order to achieve electron impedances Z/sub e/ less than 1Ω, one may have to inject high-atomic-weight plasma into the diode. (auth)

6135 (UCRL—77024) **Intense synchrotron radiation from a magnetically compressed relativistic electron layer.** Shearer, J.W.; Nowak, D.A.; Garelis, E.; Condit, W.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1975. Contract W-7405-Eng-48. 27p. (CONF-751108—1). Dep. NTIS $4.50.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

Using a simple model of a relativistic electron layer rotating in an axial magnetic field, energy gain by an increasing magnetic field and energy loss by synchrotron radiation were considered. For a typical example, initial conditions were approximately 8 MeV electron in approximately 14 kG magnetic field, at a layer radius of approximately 20 mm, and final conditions were approximately 4 MG magnetic field approximately 100 MeV electron layer energy at a layer radius of approximately 1.0 mm. In the final state, the intense 1-10 keV synchrotron radiation imposes an electron energy loss time constant of approximately 100 nanoseconds. In order to achieve these conditions in practice, the magnetic field must be compressed by an imploding conducting liner; preferably two flying rings in order to allow the synchrotron radiation to escape through the midplane. The synchrotron radiation loss rate imposes a lower limit to the liner implosion velocity required to achieve a given final electron energy (approximately 1 cm/μsec in the above example). In addition, if the electron ring can be made sufficiently strong (field reversed), the synchrotron radiation would be a unique source of high intensity soft x-radiation. (auth)

6136 Energy losses from strong electron rings trapped in RECE-Berta. Smith, A.C. Jr.; Swannack, C.E.; Fleischmann, H.H.; Phelps, D.A. (Cornell Univ., Ithaca, NY). *Nucl. Fusion;* 15: No. 3, 547-549(Jun 1975).

PLASMA KINETICS - EXPERIMENTAL

6137 Density sensitive lines of highly ionized iron. Doschek, G.A.; Feldman, U.; Davis, J.; Cowan, R.D. (E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, D.C. 20375). *Phys. Rev., A;* 12: No. 3, 980-986(Sep 1975).

Spectral lines from ions in the nitrogen isoelectronic sequence due to transitions of the type, $2s2p^4\ {}^2D_{3/2,5/2}\text{-}2p^5\ {}^2P_{3/2}$, and $2s2p^4\ {}^2D_{3/2}\text{-}2p^5\ {}^2P_{1/2}$, are identified in the 100-A region in laser-produced plasma spectra of titanium (Ti xvi) through cobalt (Co xxi), It is proposed that the intensities of these lines relative to the intensities of lines of the same ions due to transitions of the type $2s^22p^2\text{-}2s2p^4$ are sensitive to electron density in the range from ≅ 10^{18} to ≅ 10^{20} cm^{-3}. Calculations are performed for Fe xx, and a similar calculation is performed for a density-sensitive line ratio of Fe xix, i.e., $(2s2p^5\ {}^1P_1\text{-}2p^6\ {}^1S_0)/(2s^22p^4\ {}^1S_0\text{-}2s2p^5\ {}^1P_1)$. This line ratio is also sensitive to electron density between about 10^{18} and 10^{20} cm^{-3}. The $2s2p^5\ {}^1P_1\text{-}2p^6\ {}^1S_0$ line is newly indentified in Cr xvii, Co xx, and Ni xxi.

6138 Collisional rate coefficients for the iron ions Fe(VIII), Fe(IX), and Fe(X). Datla, R.U.; Blaha, M.; Kunze, H. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev., A;* 12: No. 3, 1076-1083(Sep 1975).

Relative values of rate coefficients for excitation by electron collisions were determined experimentally for various transitions in Fe viii, Fe ix, and Fe x at two plasma conditions in a small θ-pinch. Collisional ionization rates were also obtained for these ions. The maximum errors of the relative values of the excitation rate coefficients are estimated to be plus-or-minus30% to plus-or-minus40% and those of the ionization rates to be a factor of 1.5. Iron pentacarbonyl Fe $(CO)_5$ was used as an impurity in hydrogen or helium gases. The electron temperature and density were obtained from the analysis of scattered laser light. They were in the range 60—150 eV and 10^{15} to 2 times 10^{16} cm^{-3}, although this range was not available for each ion. The excitation rate coefficients were calculated by the use of the Coulomb-Born approximation. Comparison with experiment is made within each ion and also between ionization stages. A discrepancy in previous Coulomb-Born calculations is noted for the case of Fe viii.

6139 Spectroscopic measurements on vacuum spark plasmas. Cilliers, W.A.; Datla, R.U.; Griem, H.R. (Univ. of Maryland, College Park). *Phys. Rev., A;* 12: No. 4, 1408-1418(Oct 1975).

Photoelectric spectra of the regions corresponding to resonance line emission of He-like ions of titanium, iron, and copper from a low-inductance vacuum spark were obtained, as were spectra of the regions corresponding to Kα and Kβ emission from the same elements and to Kβ emission of molybdenum. Electron temperatures are estimated from continuous x-ray emission spectra to kT/sub e/ less than or equal to 15 keV; ion temperatures from x-ray line widths to kT/sub i/ less than or equal to 10 keV. A broad peak superimposed on the visible continuum is interpreted as anomalous bremsstrahlung at twice the electron plasma frequency. The resultant electron density is N/sub e/ approximately equal to 5 x 10^{20} cm^{-3}, consistent with the absence of forbidden He-like ion lines. Experimental observations support the suggestion that the x-ray-producing dense plasmas are due to interactions between pulsed electron beams and low-temperature anode vapors or plasmas. (auth)

PLASMA KINETICS - THEORETICAL

6140 (COO—3070-130) **Stability analysis of a finite difference scheme using symbolic computation.** Reiman, A.; Bers, A. (Massachusetts Inst. of Tech., Cambridge (USA)). Jun 1975. 5p. (CONF-750606—8). Dep. NTIS $4.50.

From 7. conference on numerical simulation of plasmas; New York, New York, USA (2 Jun 1975).

Computer aided symbolic manipulation has previously been used in studies of weakly nonlinear behavior in plasmas. The application of such symbolic manipulation techniques to the study of the stability of a specific finite difference scheme is investigated. Eigenvalue calculations for the Von Neumann matrix are described. (MOW)

6141 (SAI—75-636-LJ) **One dimensional fluid numerical analysis. Final report.** Byrne, R.N.; Engebretson, A.; Hamasaki, S.; Klein, H.H.; Krall, N.A.; Mc Bride, J.B.; Sturat, G.W.; Sulton, A.L.; Tamor, S.; Wagner, C.E. (Science Applications, Inc., La Jolla, Calif. (USA)). Aug 1975. Contract AT(04-3)-1018. 395p. Dep. NTIS $22.75.

6142 (TID—26878) **General Plasma Physics II.** (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Spr 1974. Contract AT(11-1)-3073. 319p. Dep. NTIS $19.00.

Twenty eight lectures are given concerning various aspects of plasma confinement, equilibrium, diffusion, and stability in tokamaks. (MOW)

6143 Multi-group diffusion of energetic charged particles. Corman, E.G.; Loewe, W.E.; Cooper, G.E.; Winslow, A.M. (Lawrence Livermore Lab., CA). *Nucl. Fusion;* 15: No. 3, 377-386(Jun 1975).

6144 Optimization of fusion power density in the two-energy-component tokamak reactor. Jassby, D.L. (Princeton Univ., NJ). Contract AT(11-1)-3073. *Nucl. Fusion;* **15**: No. 3, 453-464(Jun 1975).

6145 Electron beam generation in plasma-filled diodes. Miller, P.A.; Poukey, J.W.; Wright, T.P. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev. Lett.;* **35**: No. 14, 940-943(6 Oct 1975).

A study has been made of the response of low-density ($\sim 10^{13}$ cm^{-3}) plasmas when subjected to the very high electric fields of relativistic-electron-beam-accelerator diodes. An anomalous resistive behavior has not been seen. Instead, sheath formation at the cathode and electron-beam generation across the sheath has been found. This has important applications to the design of diodes for future electron-beam machines.

PLASMA PRODUCTION

6146 (UCRL—77230) **Frozen ammonia micropellet generator for Baseball II-T.** Denhoy, B.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Oct 1975. Contract W-7405-Eng-48. 7p. (CONF-751125—6). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A "startup" plasma at the center of the Baseball II-T magnet was studied. This startup plasma will be used as a target for high energy neutral beams to achieve the required build-up. The target plasma will be created by irradiating a solid pellet with a laser beam. Although a deuterium pellet would be superior because of purity, the development of an ammonia pellet was undertaken because it requires a simpler technology. The ammonia target plasma is physically acceptable for the initial experiment. A frozen ammonia pellet, about 100 μm in diameter, will be irradiated with 300-J CO_2 laser, to produce a density of about 10^{13} cm^{-3} and about 1 kV temperature. (auth)

6147 Interaction of relativistic electron beams with fusion-target blowoff plasmas. Mosher, D. (Naval Research Laboratory, Washington, D. C. 20375). *Phys. Rev. Lett.;* **35**: No. 13, 851-854(29 Sep 1975).

The relativistic Boltzmann equation with a Fokker-Planck collision term is solved assuming that elastic scattering characterizes the shortest time scale of the beam-plasma system. One-dimensional solutions containing the self-consistent return-current electric field show that, although range shortening occurs, the electric field prevents high-current-density beams from penetrating into the dense-plasma region.

6148 Near-field measurements of subnanosecond-created laser plasmas. Olsen, J.N.; Mendel, C.W. Jr. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Appl. Phys.;* **46**: No. 10, 4407-4415(Oct 1975).

The near field of expansion for plasmas created by a 40-psec 1.0—1.5-J laser has been probed to measure the electron density and local electric and magnetic fields. Holographic interferometry was used to measure the electron density in the range 10^{17} to 6times10^{18} cm^{-3} at delays of 2.5—22 nsec. Space-charge electric fields of up to 1900 V/cm were detected by deflection of a fast He^+ ion beam probe as late as 26 nsec after irradiation. Spontaneous magnetic fields of up to 50 G, rising in 10 nsec, were seen 4 mm from the target, decaying rapidly and often reversing at 8 mm. The temperature in the blowoff estimated from the combination of local electric field and electron-density scale length is high compared to predictions based on a peak T/sube/=160 eV inferred from a multichannel soft x-ray spectral analysis. An anisotropic fast ion group appears in the interferometric density profiles and ejection of $\sim 10^9$ fast electrons is observed in the electric field measurements. These effects are compared to the early time ion collector signal and nonthermal x-ray spectrum, respectively.

6149 Observation of anode ions associated with pinching in a relativistic electron beam diode. Swain, D.W.; Goldstein, S.A.; Kelly, J.G.; Hadley, G.R. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Appl. Phys.;* **46**: No. 10, 4604-4605(Oct 1975).

Ions originating at the anode of a relativistic electron beam (REB) accelerator are observed at the cathode by a means of a Faraday cup. The dominant species is H^+, probably from adsorbed impurities. These ions, having energies equal to the diode voltage, are not observed until 20—40 J/cm^2 are deposited by the beam on the anode surface, and are closely associated with the formation of a pinch at the anode.

PLASMA INSTABILITIES

6150 (LA—6130-MS) **Vlasov-fluid model with electron pressure.** Gerwin, R. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1975. Contract W-7405-ENG-36. 11p. Dep. NTIS $4.00.

The Vlasov-ion, fluid-electron model of Freidberg for studying the linear stability of hot-ion pinch configurations is here extended to include electron pressure. Within the framework of an adiabatic electron-gas picture, it is shown that this model is still amenable to the numerical methods described by Lewis and Freidberg. (auth)

6151 (MATT—1153) **Finite beta and resonant electron effects on trapped-electron instabilities.** Tang, W.M.; Liu, C.S.; Rosenbluth, M.N.; Catto, P.J.; Callen, J.D. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 40p. Dep. NTIS $4.00.

Finite β (plasma pressure/magnetic pressure) and resonant electron effects on the dissipative trapped-electron instabilities are analyzed. These modifications are shown to have a strong stabilizing influence on the finite ion gyroradius and electron temperature gradient driven modes, respectively. For relevant tokamak parameters complete stabilization may be possible. Stability criteria for radially local and nonlocal cases are presented. (auth)

6152 (MATT—1160) **Parametric instabilities and plasma heating in an inhomogeneous plasma.** Porkolab, M.; Arunasalam, V.; Luhmann, N.C. Jr.; Schmitt, J.P.M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 35p. Dep. NTIS $4.00.

Experimental studies of plasma heating due to microwave irradiation of the magnetically confined plasma column in the Princeton L-3 device is presented. X-band (10.4 GHz) microwave power, both in the ordinary and the extraordinary modes of propagation, is used in these experiments. Plasma heating is observed to occur simultaneously with the occurrence of parametric decay instabilities. The mode structure of the pump wave and the decay ion wave dispersion has been measured with high frequency probes. Detailed measurements of electron heating rates are presented and compared with collisional heating rates. In addition, production of suprathermal electrons and ions is also observed and measured. A comparison is made with recent laser-pellet interaction experiments. (auth)

6153 (MATT—1167) **Inhibition of the current-driven ion wave instability by electron trapping in the FM-1 spherator.** Arunasalam, V.; Okabayaski, M.; Hawryluk, R.J.; Suckewer, S. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 13p. Dep. NTIS $4.00.

An experimental analysis is made of the scattering of microwaves by the density fluctuations due to the current-driven ion wave instability in a toroidal plasma confinement device, the FM-1 spherator. It is found that the instability exists in the collisional regime and it is inhibited (i.e., quenched by two orders in magnitude) in the trapped-electron (i.e., banana) regime. The inhibition occurs when the electron collision frequency is about equal to the electron bounce frequency between mirror trapping. (auth)

6154 (MATT—1169) **Saturation of the parametric decay instability near the lower hybrid frequency.** Chen, L.; Berger, R.L. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 13p. Dep. NTIS $4.00.

The nonlinear evolution and saturation of parametrically excited lower hybrid waves are studied numerically by solving the corresponding weak turbulence wave kinetic equation. The saturation level and the effective collision frequency ν/sub f/ are obtained as functions of pump power. (auth)

6155 (UCRL-Trans—10915) **Modified negative-mass instability in the A.S. machine.** Zhurkovskii, V.G.; Timofeev, A.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1974. Translation of IAE—2438. 24p. Dep. NTIS $4.50.

It is shown that the theory of modified negative-mass instability is capable of explaining the main features of the so-called second instability observed in the AS machine. Critical analysis of the following condition is satisfied: eta/sub n/ = nω/sub i/lambda^2/4L$^2\Omega$ less than or equal to 1 where n is the number of the cyclotron harmonic, ω/sub i/ is the ion cyclotron frequency, lambda is the amplitude of ion oscillations between the trap mirrors, Ω is the frequency of these oscillations, and L is the characteristic scale of change in the magnetic field. (auth)

6156 Flute instabilities in two-dimensional simulations of strongly inhomogeneous theta-pinch plasmas. Winske, D.; Hewett, D.W. (Los Alamos Scientific Laboratory, University of California,

Los Alamos, New Mexico 87545). *Phys. Rev. Lett.*; 35: No. 14, 937-940(6 Oct 1975).

Particle simulations initialized with inhomogeneous, self-consistent Vlasov equilibria that model theta pinches in the implosion and post-implosion phases have revealed a strongly unstable flute mode for T/subi/>T/sube/. Frequencies and wavelengths are in good agreement with the linear theory of the lower-hybrid-drift instability. Results agree with quasilinear estimates of heating rates and anomalous resistivity during the initial stages of the instability. The nonlinear saturation of the turbulence is consitent with ion trapping.

PLASMA WAVE PHENOMENA

6157 **Nonlinear filamentation of lower-hybrid cones.** Morales, G.J.; Lee, Y.C. (Department of Physics, University of California, Los Angeles, California 90024). *Phys. Rev. Lett.*; 35: No. 14, 930-933(6 Oct 1975).

The nonlinear distortion of the propagation cones of lower-hybrid waves is shown to be governed by the modified Kortewegde Vries equation. Since such an equation admits exact solutions of the multiple-soliton form, it is predicted that filamented cones sould be formed when large-amplitude lower-hybrid waves are excited in a plasma.

THERMONUCLEAR POWER PLANTS

6158 (CONF-751125—60) **Oak Ridge EPR reference design.** Roberts, M. (Oak Ridge National Lab., Tenn. (USA)). 1975. 5p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A Tokamak EPR reference design is presented as a basis for further study leading to a conceptual design. The set of basic plasma parameters selected, namely, minor radius of 2.25 m, major radius of 6.75 m, magnetic field on axis of 4.8 T and plasma current of 7.2 MA, should produce a reactor-grade plasma with a significant neutron flux even with the large uncertainty in plasma physics scaling from present experience to large sizes. Neutronics and heat transfer calculations coupled with mechanical design and materials considerations were used to develop a blanket and shield capable of operating at high temperature, protecting the surrounding coils, being maintained remotely and, in a few experimental modules, breeding tritium. The toroidal field coil design developed for a maximum field of 11 T at the winding combines the use of multifilamentary Nb_3Sn and NbTi superconducting cables (in high and low field regions, respectively) with forced flow of supercritical helium enclosed in a steel conduit. The poloidal magnetics system is specially designed both to reduce the total volt-second energy requirements and to reduce the rate of field change at the toroidal field coils. The reference design was synthesized from the information developed and evaluated in our prior scoping study. (auth)

6159 (CONF-751125—61) **Physics and engineering aspects of the Oak Ridge experimental power reactor.** McAlees, D.G.; Bettis, E.S.; Huxford, T.J.; Marcus, F.B. (Oak Ridge National Lab., Tenn. (USA)). 1975. 5p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The first tokamak experimental power reactor (EPR) is planned for operation in the mid-1980's. The logic leading to the size of the ORNL reference reactor, the technical features of the plasma and energy conversion systems, and the predicted parameters consistent with several operating modes are discussed. The mechanical aspects of the blanket and shield systems and an evaluation of their nuclear performance including tritium breeding, nuclear heating and radiation damage are also given. (auth)

6160 (CONF-751125—63) **Engineering features of ISX.** Lousteau, D.C.; Jernigan, T.C.; Schaffer, M.J.; Hussung, R.O. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1975. 12p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

ISX, an Impurity Study Experiment, is presently being designed at Oak Ridge National Laboratory as a joint scientific effort between ORNL and General Atomic Company. ISX is a moderate size tokamak dedicated to the study of impurity production, diffusion, and control. The significant engineering features of this device are discussed. (auth)

6161 (CONF-751125—64) **ISX toroidal field coil design and analysis.** Hussung, R.O.; Lousteau, D.C.; Johnson, N.E.; Weed, R.A. (Oak Ridge National Lab., Tenn. (USA)). 1975. 18p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Structural design and analysis aspects of the toroidal field coils for the Impurity Study Experiment (ISX) tokamak are discussed. The overall mechanical design of ISX is predicated on the ability to remove the upper segment of the toroidal field coils to allow access to the toroidal vacuum vessel. The high current, 120 kA, capability of the new 74 MW power supply, coupled with the modest field requirement of ISX, allows the use of room temperature copper coils. Seventy-two turns, grouped into 18 coils, generate a magnet field of 18 kG at the major radius of 90 cm. Finite element structural analysis codes were utilized to determine the distribution of stresses and deflections around a typical turn. Initial material distribution on a coil was sized using the two-dimensional program FEATS. The resulting coil design was then coupled to the center bucking and out-of-plane restraint systems utilizing the NASTRAN code. The boundary conditions for the analytical models used in the two programs were then iterated, reaching satisfactory agreement as to stress contours and location for the joints. (auth)

6162 (ERDA—89) **Summary of the proceedings of the workshop on conceptual design studies of experimental power reactor-1.** Murphy, M.; Neff, J. (eds.). (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Controlled Thermonuclear Research). Nov 1975. 81p. Dep. NTIS $5.45.

This document summarizes the proceedings of the first workshop which was convened to discuss the conceptual design of the EPR-I. The workshop, which was held September 9-10, 1975 at Oak Ridge, covered fifteen different topics relating to various reactor systems for EPR-I. The EPR scoping studied completed by ANL, GA and ORNL formed the basis of the discussions. In each of the session summaries, a discussion of the various designs, and of the R and D programs necessary to provide the technology base required for the designs, are discussed in varying detail. (auth)

6163 (LA-UR—75-2153) **Engineering prototypes for theta-pinch devices.** Hansborough, L.D.; Hammer, C.F.; Hanks, K.W.; McDonald, T.E.; Nunnally, W.C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 7p. (CONF-751125—47). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Past, present, and future engineering prototypes for theta-pinch plasma-physics devices at Los Alamos Scientific Laboratory are discussed. Engineering prototypes are designed to test and evaluate all components under system conditions expected on actual plasma-physics experimental devices. The importance of engineering prototype development increases as the size and complexity of the plasma-physics device increases. Past experiences with the Scyllac prototype and the Staged Theta-Pinch prototype are discussed and evaluated. The design of the proposed Staged Scyllac prototype and the Large Staged Scyllac implosion prototype assembly are discussed. (auth)

6164 (MATT—1170) **Prospects for thermonuclear ignition in a "collisional" tokamak.** Cohn, D.R.; Jassby, D.L.; Parker, R.R. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract AT(11-1)-3073. 15p. Dep. NTIS $4.00.

The parameters are described for a tokamak reactor plasma that attains ignition in the same regime of collisionality as present-day ohmic-heated tokamak plasmas, where the confinement scaling $n\tau_E \propto n^2$ is observed. The use of Nb_3Sn toroidal field coils and a plasma elongation greater than or equal to 1.5 are necessary to attain the high plasma density (n approximately 10^{15} cm^{-3}) required for ignition in this collisional regime. Under these conditions, the fusion power density is of order 10 W/cm^3. This high value is probably necessary for an economic tokamak reactor. (auth)

6165 (ORNL-TM—4820) **Description of a reference design tokamak for the Technology Test Assembly.** Haubenreich, P.N. (ed.). (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 125p. Dep. NTIS $5.45.

Early conceptual studies for the Technology Test Assembly involved a reference conceptual design for a tokamak with superconducting toroidal field magnets. The TF magnet conductors are NbTi filaments in a copper matrix. The 24 TF coils and associated structure operate at 4—5 K and a maximum field (at the windings) of 75 kG. Principal dimensions of the machine are: TF coil bore, 1.8 x 2.4 m (oval); major radius, 2.25 m; plasma minor radius, 0.6 m. A preliminary but detailed cost estimate for the reference machine was prepared to serve as an anchor point for cost scaling for larger machines in subsequent TTA parameter studies. (auth)

6166 (UCRL—50002-74) **Controlled thermonuclear research. Annual report, July 1973—June 1974.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Oct 1974. Contract W-7405-Eng-48. 92p. Dep. NTIS $5.45.

The Controlled Thermonuclear Research (CTR) program at Lawrence Livermore Laboratory this year was marked by two major changes in the course of the experimental program: the adaption of high-power neutral beam heating in the 2X experiment, and the decision to change the startup mode in the Baseball II experiment to one in which a laser pellet technique is used to produce a transient, high-density target plasma. Supporting research centered on technologies vital to the mirror confinement program, e.g., development of intense neutral beams, of high-field superconducting magnets, and of direct energy conversion. In addition, a preliminary design study of fusion-fission hybrid systems was completed, as was a parametric study of mirror fusion reactors. The diverse experience of LLL in nuclear physics and materials research was applied to continuing 14-MeV neutron studies and tritium research. Much of the theory effort was devoted to the development of codes that describe the equilibrium of plasma under the assumption that only classical loss mechanisms prevail (both experimental and theoretical indications are that plasma loss at high density is dominated by these mechanisms). Also, both open-ended and toroidal two-component mirror systems have been studied. (auth)

6167 (UCRL—76985) **Mirror fusion reactor study.** Carlson, G.A.; Moir, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Nov 1975. Contract W-7405-ENG-48. 46p. (CONF-751101—60). Dep. NTIS $5.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The principal features of a fusion power reactor employing the magnetic mirror confinement concept are described. A parametric design and cost estimate analysis has been used to optimize the design for minimum capital cost per net electric output. Optimized parameters include the vacuum mirror ratio, the injection energy and angle, the choice of a thermal conversion cycle, and the design efficiency of the charged particle direct converter. The sensitivity of the cost of power for the optimized design to variations in many of the reactor parameters is discussed. (auth)

6168 (UCRL—77233) **Preliminary conceptual engineering design considerations for the MX machine.** Bulmer, R.H.; Calderon, M.U.; Hibbs, S.M.; Kozman, T.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Oct 1975. 8p. (CONF-751125—2). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The mirror experiment was designed to develop the technologies necessary to make the transition from the presently small-scale physics experiments (2XIIB and BBII) to large-scale steady-state DT burning systems, such as the Fusion Engineering Research Facility (FERF) and Controlled Thermonuclear Reactors (CTR) based on plasma confinement in open magnetic geometry. The confinement parameters in the design of the present machine include a 20-kG central field with a mirror ratio of 2 to 1 and an overall BL product approximately 5 times greater than that currently available with the 2XIIB compression coils (or a mirror-to-mirror length of 3.4 m). Several types of Yin-Yang minimum parallel B parallel geometries were studied, and a "displaced" Yin-Yang was chosen because the center of the machine is easily accessable between the coils and between the magnet lobes. Other important design considerations include the target plasma system, the vacuum system, and the injectors. The target plasma system includes a pellet generating system used to produce a 400-μm deuterium pellet and a two-arm laser system where the laser energy is produced from a 1-kJ, 10-GW CO_2 laser at 100 ns. (MOW)

6169 (UCRL—77243) **Laser startup optics for Baseball II and future mirror machines.** Frank, A.M.; Chargin, A.K.; Brown, N.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Oct 1975. Contract W-7405-Eng-48. 9p. (CONF-751125—5). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The laser startup system for Baseball II-T uses a 300-J CO_2 laser to hit a 100-μ diameter pellet with a laser power density on the order of 10^{12} W/cm^2. The laser is a 20-cm diameter unstable resonator transversely excited (TEA) oscillator. The beam is split and then focused using off-axis parabolas. The symmetric configuration and central obscuration of the CO_2 beam allow coaxial alignment and pellet detection optics. This experiment primarily uses commercially available systems and components. Optical elements were fabricated both by direct machining and standard polishing techniques. The laser and optical systems are directly scalable to reactor requirements using demonstrated technologies. (auth)

6170 (UCRL—77260) **Vibrational, thermal, and alignment considerations of the laser system for Baseball II-T.** Thomas, S.R. Jr.; Chargin, A.; Denhoy, B.; Johnson, B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Nov 1975. Contract W-7405-Eng-48. 8p. (CONF-751125—1). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Designing the Baseball II-T laser system required addressing a number of mechanical parameters. Among them are low frequency floor vibrations, high acoustical noise levels, and large thermal fluctuations in the vicinity of the experiment. In addition, the 8-in. apertures from the 300-K environment of the laser system had to be compatible with the cryogenic environment of the superconducting Baseball magnet. This paper discusses these problems and describes their influence on the laser system design. (auth)

6171 (UCRL—77264) **Baseball II-T, a new target plasma startup experiment.** Chargin, A.; Denhoy, B.; Frank, A.; Thomas, S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Nov 1975. Contract W-7405-Eng-48. 6p. (CONF-751125—19). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A brief description is given of modifications and additions to the existing Baseball II experiment. These changes will make it possible to study target plasma buildup in a steady-state magnetic field. This experiment, now called Baseball II-T$^+$ will use a pellet generator to deliver ammonia pellets into the center of the magnetic mirror field where they will be heated with a 300-J, 50-ns, CO_2 laser. The plasma created by this method will have a density of approximately 10^{13} cm^{-3} and a temperature of about 1 keV. This target plasma will be used for neutral beam injection startup studies with a 50-A, 20-keV neutral beam. Later, the beam power will be increased to study buildup. With ion injection energies of up to 50 keV, it may be possible to achieve etatau as high as 10^{12} cm^{-3} s. The new components necessary to achieve these goals are described. (auth)

6172 (UCRL—77269) **Project planning and project management of Baseball II-T.** Kozman, T.A.; Chargin, A.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Oct 1975. 6p. (CONF-751125—3). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The details of the project planning and project management work done on the Baseball II-T experiment are reviewed. The LLL Baseball program is a plasma confinement experiment accomplished with a superconducting magnet in the shape of a baseball seam. Both project planning and project management made use of the Critical Path Management (CPM) computer code. The computer code, input, and results from the project planning and project management runs, and the cost and effectiveness of this method of systems planning are discussed. (auth)

6173 **Tokamak research.** Furth, H.P. (Princeton Univ., NJ). Contract E(11-1)-3073. *Nucl. Fusion;* **15**: No. 3, 487-534(Jun 1975).

6174 **Problems and promises of controlled fusion power.** Mills, R.G. (Princeton Univ., NJ). *Mech. Eng.;* **97**: No. 9, 20-25(Sep 1975).

A general review of controlled fusion research is given. Some of the technical details of a power producing plant are discussed. Some fuel cycles and their advantages are described. (MOW)

PHYSICS AND BLANKET ENGINEERING

6175 (CONF-751125—41) **Comparison of the leading candidate combinations of blanket materials, thermodynamic cycles, and tritium systems for full scale fusion power plants.** Fraas, A.P. (Oak Ridge National Lab., Tenn. (USA)). 1975. 23p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The many possible combinations of blanket materials, tritium generation and recovery systems, and power conversion systems were surveyed and a comprehensive set of designs were generated by using a common set of ground rules that include all of the boundary conditions that could be envisioned for a full-scale commercial fusion power plant. Particular attention was given to the effects of blanket temperature on power plant cycle efficiency and economics, the interdependence of the thermodynamic cycle and the tritium recovery system, and to thermal and pressure stresses in the blanket structure. The results indicate that, of the wide variety of systems that have been considered, the most

promising employs lithium recirculated in a closed loop within a niobium blanket structure and cooled with boiling potassium or cesium. This approach gives the simplest and lowest cost tritium recovery system, the lowest pressure and thermal stresses, the simplest structure with the lowest probability of a leak, the greatest resistance to damage from a plasma energy dump, and the lowest rate of plasma contamination by either outgassing or sputtering. The only other blanket materials combination that appears fairly likely to give a satisfactory tritium generation and recovery system is a lithium-beryllium fluoride-Incoloy blanket, and even this system involves major uncertainties in the effectiveness, size, and cost of the tritium recovery system. Further, the Li_2BeF_4 blanket system has the disadvantage that the world reserves of beryllium are too limited to support a full-blown fusion reactor economy, its poor thermal conductivity leads to cooling difficulties and a requirement for a complex structure with intricate cooling passages, and this inherently leads to an expansive blanket with a relatively high probability of leaks. The other blanket materials combinations yield even less attractive systems. (auth)

6176 (ORNL-TM—5036) **Calculated performance of various structural materials in fusion-reactor blankets.** Williams, M.L.; Santoro, R.T.; Gabriel, T.A. (Oak Ridge National Lab., Tenn. (USA)). Dec 1975. Contract W-7405-eng-26. 27p. Dep. NTIS $5.00.

The calculated nuclear performances of niobium, SS-304, and nimonic-105 as structural materials in a conceptual D-T fusion-reactor blanket model are compared. For each structural material, the tritium breeding ratio, the energy-deposition rate, the operating dose, the time dependence of the neutron-induced activity, the time dependence of the dose from the activation products, the time dependence of the nuclear afterheat, and the atomic displacement rate are calculated. Emphasis is placed on the nuclear response in the first structural wall to the selected structural material for an assumed neutron wall loading of 1 MW/m^2. Taking into account all of the nuclear responses, SS-304 appears to be a reasonable choice as the structural material for fusion-reactor application. (auth)

MAGNET COILS AND FIELDS

6177 (BNL—20581) **High-energy neutron irradiation of superconducting compounds.** Sweedler, A.R.; Snead, C.L.; Newkirk, L.; Valencia, F.; Geballe, T.H.; Schwall, R.H.; Matthias, B.T.; Corenswit, E. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 17p. (CONF-751026—33). Dep. NTIS $4.50.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

The effect of high-energy neutron irradiation (E greater than 1 MeV) at ambient reactor temperatures on the superconducting properties of a variety of superconducting compounds is reported. The materials studied include the A-15 compounds Nb_3Sn, Nb_3Al, Nb_3Ga, Nb_3Ge and V_3Si, the C-15 Laves phase HfV_2, the ternary molybdenum sulfide $Mo_3Pb_{0.5}S_4$ and the layered dichalcogenide $NbSe_2$. The superconducting transition temperature has been measured for all of the above materials for neutron fluences up to 5×10^{19} n/cm^2. The critical current for multifilamentary Nb_3Sn has also been determined for fields up to 16 T and fluences between 3×10^{17} n/cm^2 and 1.1×10^{19} n/cm^2. (auth)

6178 (CONF-751125—8) **Toroidal field ripple effects in large tokamaks.** Uckan, N.A.; Tsang, K.T.; Callen, J.D. (Oak Ridge National Lab., Tenn. (USA)). 1975. 5p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

In an experimental power reactor, the ripple produced by the finite number of toroidal field coils destroys the ideal axisymmetry of the configuration and is responsible for additional particle trapping, loss regions and plasma transport. The effects of toroidal field ripple on the plasma transport coefficient, the loss of alpha particles and energetic injection ions, and the relaxation of toroidal flows are investigated in a new and systematic way. The relevant results are applied to the ORNL-EPR reference design; the maximum ripple there of about 2.2 percent at the outer edge of the plasma column is found to be tolerable from plasma physics considerations. (auth)

6179 (CONF-751125—35) **Design of the metastable eccentric coil test.** Luton, J.N.; Ballou, J.K. (Oak Ridge National Lab., Tenn. (USA)). 1975. 8p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The Eccentric Coil Test (ECT) described herein was a proposed facility for testing individual superconducting coils under conditions similar to those encountered by a toroidal field coil of a tokamak. In order to arrive at designs worthy of large scale proof testing, one needs the results of tests in a facility which (a) can separate the effects of the different variables, (b) has the possibility of pushing the test coil to "failure" in different waves, and (c) in which several different test coils can be studied without excessive costs in time or money. ECT consists of a relatively large background coil, a replaceable test coil, and small coils for the production of localized pulsed fields. The midplanes of the test and background coils are coincident, but their axes are displaced in order to provide asymmetric magnetic forces on the test coil. The background coil inside diameter is 89 cm; a variety of test coil sizes can be accommodated. Included in the discussion is the rationale of the test, objectives and requirements, a description of the apparatus, and predicted performance. (auth)

6180 (CONF-751125—36) **Experiment to measure the effects of biaxial strain on the critical current of NbTi superconductor.** Froelich, K.J. (Oak Ridge National Lab., Tenn. (USA)). 1975. 4p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Twisted multifilament, copper-clad NbTi superconductors have been axially and biaxially strained at 4.2K with a 7.5T background field. A simply-constructed cryogenic loading frame was built and used to strain the conductor. Results on 1.27 mm x 3.13 mm conductor have shown that degradation of less than .3 percent of critical current occurred when the wire was biaxially strained to +3260 μepsilon in the axial direction and -1875 μepsilon in the transverse direction. Degradation approaches 3 percent of critical current at approximately 6000 μepsilon in the axial direction only. (auth)

6181 (CONF-751125—38) **Preparation and extrusion of multifilamentary NbTi conductor billets.** Fietz, W.A.; McDonald, R.E.; Miller, J.R. (Oak Ridge National Lab., Tenn. (USA)). 1975. 6p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

In a cooperative program with industrial superconducting wire manufacturers for the purpose of studying billet preparation and extrusion, a total of twenty billets were assembled. Fourteen of these contained no superconductor but were "dummy" billets to evaluate methods of stacking to achieve the best packing density. These billets were not extruded but were sectioned transversely and longitudinally for evaluation of billet preparation techniques. The remaining six billets were assembled with NbTi stacking elements in a copper/copper nickel matrix using a standard conductor configuration. Two of these billets were instrumented with thermocouples and used to evaluate preheating techniques. The other four were extruded and drawn to finished conductor size for critical current measurement. This study showed that hexagonal stacking elements, contoured billet jackets and hot isostatic pressing resulted in high density uniform billets for extrusion. Rotary forging was found to be unacceptable for billet compacting. Fast billet heating was achieved in both the salt bath and by induction heating, but the induction method gave a more uniform temperature distribution during the heating cycle. Asymmetry from poor packing density in the billet resulted in nonuniform filament size distributions and poor critical current performance. Billet yield was increased as much as 16 percent by contouring the stacking element positions within the billet. (auth)

6182 (CONF-751125—39) **Transient poloidal field effects in twisted multifilamentary superconductor for toroidal field windings of tokamaks.** Shen, S.S.; Miller, J.R. (Oak Ridge National Lab., Tenn. (USA)). 1975. 8p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A circuit model is presented for a twisted filamentary superconductor exposed to a pulsed parallel external field. Experimental results are also reported on the measurements of transient loss voltage and its change due to transport current. The measurements are in reasonable agreement with that predicted by the postulated model. (auth)

6183 (CONF-751125—42) **Large superconducting coil fabrication development.** Brown, R.L.; Allred, E.L.; Anderson, W.C.; Burn, P.B.; Deaderick, R.I.; Henderson, G.M.; Marguerat, E.F. (Oak Ridge National Lab., Tenn. (USA)). 1975. 5p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Toroidal fields for some fusion devices will be produced by an array of large superconducting coils. Their size, space limitation, and field requirements dictate that they be high performance coils. Once installed, accessibility for maintenance and repairs is severely restricted; therefore, good reliability is an obvious necessity. Sufficient coil fabrication will be undertaken to develop and

test methods that are reliable, fast, and economical. Industrial participation will be encouraged from the outset to insure smooth transition from development phases to production phases. Initially, practice equipment for three meter bore circular coils will be developed. Oval shape coil forms will be included in the practice facility later. Equipment that is more automated will be developed with the expectation of winding faster and obtaining good coil quality. Alternate types of coil construction, methods of winding and insulating, will be investigated. Handling and assembly problems will be studied. All technology developed must be feasible for scaling up when much larger coils are needed. Experimental power reactors may need coils having six meter or larger bores. (auth)

6184 (CONF-751125—45) **Photoelastic and analytical investigation of stress in toroidal magnetic field coils.** Pih, H.; Gray, W.H. (Oak Ridge National Lab., Tenn. (USA)). 1975. 6p. Dep. NTIS $4.00.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A series of two-dimensional photoelastic stress analyses on circular and oval toroidal magnetic field coils for fusion reactors were made. The circumferential variation of the coil's magnetic force was simulated by applying different pressures to sixteen segmented regions of the inner surface of the models. Isochromatics and isoclinics were measured at selected points on the loaded model in a transmission polariscope using a microphotometer. Separate principal stresses were obtained using the combination of photoelastic information and isopachic data measured from the solution of Laplace's equation by the electrical analog method. Analysis of the same coil geometries, loadings, and boundary conditions were made using the finite element method. General agreement between theory and experiment was realized. From this investigation several variations of coil geometry and methods of support were evaluated. Based upon this experiment, suggestions for optimum structural design of toroidal field coils are presented. (auth)

6185 (CONF-751125—58) **Toroidal simulation magnet tests.** Walstrom, P.L.; Domm, T.C. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1975. 5p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A number of different schemes for testing superconducting coils in a simulated tokamak environment are analyzed for their merits relative to a set of test criteria. Two of the concepts are examined in more detail: the so-called cluster test scheme, which employs two large background field coils, one on either side of the test coil, and the compact torus, a low-aspect ratio toroidal array of a small number of coils in which all of the coils are essentially test coils. Simulation of the pulsed fields of the tokamak is discussed briefly. (auth)

6186 (CONF-751125—62) **Magnetic field shielding system in a tokamak experimental power reactor (EPR): concept and calculations.** Peng, Y.K.M.; Marcus, F.B.; Dory, R.A.; Moore, J.R. (Oak Ridge National Lab., Tenn. (USA)). 1975. 4p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A poloidal magnetic field shielding system is proposed for a tokamak EPR. This coil system minimizes the pulsed poloidal field that intersects the TF (toroidal field) coils and hence reduces the risk of superconductor quenching and structural failure of the coils. Based on an idealized shielding model, we have determined the configurations for the OH (ohmic heating), the S-VF (shield-vertical field), and the T-VF (trimming-vertical field) coils in a typical tokamak EPR. It is found that the pulsed poloidal field strength is greatly reduced in the TF coil region. The overall requirement in stored plasma and vertical field energy is also substantially reduced when compared with conventional EPR designs. Use of this field shielding system is expected to enhance reliability of the superconducting TF coils in a tokamak EPR. (auth)

6187 (CONF-751125—66) **Thermal aspects of a superconducting coil for fusion reactor.** Yeh, H.T. (Oak Ridge National Lab., Tenn. (USA)). 1975. 7p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Computer models are used to simulate both localized and extensive thermal excursions in a large superconducting magnet for fusion reactor. Conditions for the failure of fusion magnet due to thermal excursion are delineated. Designs to protect the magnet against such thermal excursion are evaluated. (auth)

6188 (MATT—1166) **Discrete coil torus with lower field ripple.** Sheffield, G.V. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 9p. Dep. NTIS $4.50.

A new toroidal field coil configuration is described which allows one to reduce the volume of a toroidal field coil system or the number of coils constituting such a system without increasing the toroidal field ripple. (auth)

6189 (ORNL—5077) **Scaling relations for eddy current phenomena.** Dodd, C.V.; Deeds, W.E. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 38p. Dep. NTIS $4.00.

Formulas are given for various electromagnetic quantities for coils in the presence of conductors, with the scaling parameters factored out so that small-scale model experiments can be related to large-scale apparatus. Particular emphasis is given to such quantities as eddy current heating, forces, power, and induced magnetic fields. For axially symmetric problems, closed-form integrals are available for the vector potential and all the other quantities obtainable from it. For unsymmetrical problems, a three-dimensional relaxation program can be used to obtain the vector potential and then the derivable quantities. Data on experimental measurements are given to verify the validity of the scaling laws for forces, inductances, and impedances. Indirectly these also support the validity of the scaling of the vector potential and all of the other quantities obtained from it. (auth)

6190 (ORNL-TM—4999) **Comparative study of the more promising combinations of blanket materials, power conversion systems, and tritium recovery and containment systems for fusion reactors.** Fraas, A.P. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 122p. Dep. NTIS $5.45.

The many possible combinations of blanket materials, tritium generation and recovery systems, and power conversion systems were surveyed first by reviewing the principal design studies that have been prepared and then by examining a comprehensive set of designs generated by using a common set of ground rules that included all of the boundary conditions that could be envisioned. The results indicate that, of the wide variety of systems that have been considered, by far the most promising employs lithium recirculated in a closed loop within a niobium blanket structure and cooled with boiling potassium or cesium. This approach gives the simplest and lowest cost tritium recovery system, the lowest pressure and thermal stresses, the simplest structure with the lowest probability of a leak, the greatest resistance to damage from a plasma energy dump, and the lowest rate of plasma contamination by either outgassing or sputtering. The only other blanket materials combination that appears fairly likely to give a satisfactory tritium generation and recovery system is an Li_2BeF_4-Incoloy blanket, and even this system involves major uncertainties in the effectiveness, size, and cost of the tritium recovery system. Further, the Li_2BeF_4 blanket system has the disadvantage that the world reserves of beryllium are too limited to support a full-blown fusion reactor economy, its poor thermal conductivity leads to cooling difficulties and a requirement for a complex structure with intricate cooling passages, and this inherently leads to an expensive blanket with a relatively high probability of leaks. The other blanket materials combinations yield even less attractive systems. (auth)

6191 (ORNL-TM—5137) **Enhancement factor of the electric field in the point-plane configuration.** Westendorp, W.F. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 19p. Dep. NTIS $4.00.

In many dielectric tests a point and plane set of electrodes is used. The point may be tungsten and can be ground accurately to a cone of specified half angle. By grinding and etching the tip may be finished to a spherical shape. The radius may be determined by optical magnification. Given the cone half angle, the tip radius and the gap, it is of interest to find the enhancement factor, i.e., the ratio of the electric field at the tip to the average electric field within the gap. A modification of a technique is outlined, that permits the determination of the enhancement factor by computer for any practical cone angle and radius and for gap lengths of 1 cm and less. (auth)

6192 (UCRL—77227) **1.1-meter bore, 8-tesla test facility.** Nelson, R.; Cornish, D.; Zbasnik, J.; Sackett, S.; Taylor, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Nov 1975. Contract W-7405-Eng-48. 6p. (CONF-751125—28). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The design and fabrication of a 1.1-m bore superconducting coil for an 8-T facility at Lawrence Livermore Laboratory are discussed. This facility will provide the backing field required for testing large multifilamentary Nb_3Sn coils as part of the superconductor development program at Livermore. The magnet measures 1.85 m o.d., is 1.5 m in length, and is solenoid wound in four separate modules. Total cold weight of the assembly is 18,000 Kg.

A NbTi superconductor is used throughout with a gradation of current density within the magnet to provide complete cryostatic stability. The preliminary design of a large 3500-A multifilamentary Nb_3Sn insert magnet is also included. Together, the backing coil and insert magnets are designed to produce a 12-T central field in a 0.4m bore. The "equal area" theory of cryostatic stability is applied in the design of both magnet systems and is discussed in detail. A large open-mouth cryostat is used and measures 2 m in diameter and 3.7 m in length. Details of Dewar design and the refrigeration requirements are included. (auth)

6193 (UCRL—77235) **Tests on multifilamentary Nb_3Sn superconductors.** Zbasnik, J.; Vandervoort, R.; Taylor, C.; Ping, D.; Hirzel, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Nov 1975. Contract W-7405-Eng-48. 6p. (CONF-751125—18). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Developmental work on multifilamentary Nb_3Sn superconductors produced by the bronze approach is described. Critical current vs field data for several types of conductors capable of carrying approximately 1000 A at 12 T are presented. Specimens with 1.4-μm-diam filaments were very difficult to process and had relatively poor superconducting properties. Specimens with 2.4-μm-diam filaments had good superconducting properties, and a degradation was observed if the samples were reacted too long. The 4.5-μm-diam filament conductor had excellent superconducting properties, and the results indicate that a 2-day reaction at 650°C was sufficient to produce these properties. Preliminary versions of a scaled-up conductor had a very broad transition. (auth)

6194 (UCRL—77241) **Explosive joints in Nb—Ti/Cu composite superconductors.** Cornish, D.N.; Zbasnik, J.P.; Pattee, H.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Nov 1975. Contract W-7405-Eng-48. 7p. (CONF-751125—25). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Explosive welding techniques have been applied to the joining of a Nb-Ti/Cu composite conductor. Details of the process are given together with mechanical and electrical evaluations of the resulting joints. (auth)

6195 (UCRL—77244) **Calculation of electromagnetic fields and forces in coil systems of arbitrary geometry .** Sackett, S.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Nov 1975. Contract W-7405-Eng-48. 7p. (CONF-751125—11). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A computer program, EFFI, is described which calculates the electric and magnetic fields due to an arbitrary spatial distribution of current-carrying circular loops, circular arcs, and straight lines. The electric field is assumed to arise solely from the time variation of the magnetic field, and the magnetic field due to the changing electric field is assumed to be negligible. In addition, the conductor bundle elements (loops, arcs, lines) are assumed to be absent. Electric and magnetic flux lines and magnetic forces and inductances are also calculated by the program. The algorithm used in the code, which is based on a combination of direct and numerical integration using the Biot-Savart law, is discussed. The methods used to maintain accuracy in calculating fields within the conductor bundle, in particular, are detailed. Several examples are then presented to illustrate the input and output features as well as the accuracy obtained and the running time required. (auth)

POWER SUPPLIES AND CIRCUITRY

6196 (LA-UR—75-2128) **Diagnosis of underdrying in paper castor oil capacitors.** Boicourt, G.P. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 8p. (CONF-751125—54). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Underdrying of the Kraft paper insulant in energy-storage capacitors can drastically shorten their life and even make them unsuitable for certain applications. When an underdryed capacitor fails in such an application, the user is often at a loss to know the reason since the diagnosis of underdrying is not an easy one to make. There are two phenomena whose appearance inside the windings of the failed capacitor, either singly or together, imply that the cause of failure was underdrying. These are margin spotting and margin arcs. These two diagnostic clues are discussed as is the empirical evidence connecting them to underdrying. Photographs showing their physical appearance are presented. A theoretical explanation is given which connects their presence to underdrying. (auth)

6197 (LA-UR—75-2129) **High voltage, high current, pulsed energy source having dI/dt's of 2 x 10^{12} A/s.** Burkhardt, L.C.; Dike, R.S.; DiMarco, J.N.; Haarman, R.A.; Schofield, A.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 4p. (CONF-751125—51). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A hybrid transfer capacitor circuit, combining one back-biased and a forward-biased capacitor bank, plus a resistor (for damping and isolation) and an inductive load has achieved inductive-storage, explosive fuse-like rates of rise, and peak amplitudes, of currents. Initial dI/dt's of approximately 2 x 10^{12} A/s are measured, with currents in the 200 kA range. The combination of explosive fuses and magnetic energy storage has been successfully used at Los Alamos Scientific Laboratory to obtain currents with risetimes of 2 x 10^{12} A/s and of 200 kA magnitude, on both linear and toroidal Z pinches. Such a system must have the characteristic of initially high vector E fields during the formation of the pinch, but with low vector E fields along the plasma chamber's wall after the pinch has been formed. The voltage left on a simple capacitor system will cause secondary wall breakdown, which short-circuits the previously formed pinch. (Conceivably a crowbar of extremely low inductance could then remove the residual voltage; in practice, however, the attendant L/R decay time is too short for most pinch experiments.) (auth)

6198 (LA-UR—75-2154) **Implosion heating in the scyllac fusion test reactor.** Lindord, R.K.; Nunnally, W.C.; Thomassen, K.I. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 6p. (CONF-751125—52). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The Scyllac Fusion Test Reactor (SFTR) is a large-radius toroidal theta-pinch experiment in the Controlled Thermonuclear Research program at the Los Alamos Scientific Laboratory. The SFTR is designed for D-T operation to achieve Q = 1, i.e., the total neutron energy at 20 MeV/neutron is equal to the internal energy of the plasma with an expected average confinement time of the plasma in the range of 200 ms. One of the most important and technologically challenging systems in the SFTR is the implosion-heating system. This system provides the implosion-heating field which must rise to approximately 8 kG in 100 to 200 ns and then crow-barred with a sufficiently long L/R time to allow the compression field to be brought up. The system employs 54-kV capacitors as the energy source arranged in a low-inductance configuration in order to obtain a short risetime with a minimum of voltage and energy. This paper describes the design and discusses the expected operating performance of the implosion-heating system. (auth)

6199 (LA-UR—75-2158) **Scyllac equipment reliability analysis.** Gutscher, W.D.; Johnson, K.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-751125—55). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Most of the failures in Scyllac can be related to crowbar trigger cable faults. A new cable has been designed, procured, and is currently undergoing evaluation. When the new cable has been proven, it will be worked into the system as quickly as possible without causing too much additional down time. The cable-tip problem may not be easy or even desirable to solve. A tightly fastened permanent connection that maximizes contact area would be more reliable than the plug-in type of connection in use now, but it would make system changes and repairs much more difficult. The balance of the failures have such a low occurrence rate that they do not cause much down time and no major effort is underway to eliminate them. Even though Scyllac was built as an experimental system and has many thousands of components, its reliability is very good. Because of this the experiment has been able to progress at a reasonable pace. (auth)

6200 (LA-UR—75-2183) **Final installation and testing of the feedback power amplifier for the Scyllac feedback experiment.** Kutac, K.J.; Kewish, R.W. Jr.; Gribble, R.F.; Rawcliffe, A.S.; Miller, G.; Kemp, E.L.; Bartsch, R.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 10p. (CONF-751125—53). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The Scyllac feedback system consists of eight subsystems. The installation and testing of the many components and eight subsystems are described. The eight subsystems are: (1) ML-8618 power amplifiers; (2) dc plate and bias power supplies; (3) ac filament power supplies; (4) position detector and signal processor (intermediate amplifier); (5) l = 0 and l = 2 output load coils; (6) control system and interlock system; (7) computer controlled

analog-to-digital transient recorders; and (8) cable distribution and cooling-water supply system. (auth)

6201 (UCRL—77215) **Construction and testing of the 2XIIB flat-topping power supply.** Refigato, L.L.; Smith, B.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Nov 1975. Contract W-7405-Eng-48. 4p. (CONF-751125—20). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The construction details and test results of the 2XIIB flat-topping modules are described. Both practical design and construction considerations as well as fabrication techniques are discussed. Power for the main compression coils of the 2XIIB is derived by discharging a high-voltage capacitor bank and then crowbarring at the current peak to obtain L/R decay in the fields. To study plasma confinement under these quasi steady-state conditions, it is necessary to hold the compression-coil current constant for 10 ms. This is done by supplying only the I^2R losses of the system, using a low-voltage bank. The low-voltage bank consists of 48 modules each supplying 20,000 A at +-450 V to each compression coil for a total of 480,000 A. The low-voltage electrolytic bank is isolated from the high-voltage (20-kV) bank by silicon diodes, which also act as crowbars at the end of the 10-ms flat-topping or in the event that the electrolytic bank is not used. The 10-ms pulse is obtained by sequentially discharging ten electrolytic "drawers," each supplying a 1-ms pulse to each of the 48 modules. Each "drawer" consists of 24 1500-μf electrolytic capacitors controlled by a thyristor and isolated from each other by rectifier diodes. Inductors are included as part of each drawer to limit the di/dt of the thyristor during the commutation process. (auth)

6202 (ANL-Trans—1022) **Simplified theory of high efficiency inductive transfer processes.** Rioux, C. Translated from *Rev. Phys. Appl.*; **10**: No. 2, 75-79(Mar 1975). 12p. Dep. NTIS $4.50.

A system using only inductances and opening and closing switches has been developed to transfer energy from a storage inductance to any given load with a very high efficiency. Even higher efficiencies can be achieved if a number of small capacitors are used. (auth)

FUEL SYSTEMS

6203 (BNWL—1938) **Analysis of tritium releases to the atmosphere by a CTR.** Renne, D.S.; Sandusky, W.F.; Dana, M.T. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1975. Contract E(45-1)-1830. 54p. Dep. NTIS $5.45.

Removal by atmospheric processes of routinely and accidentally released tritium from a controlled thermonuclear reactor (CTR) was investigated. Based on previous studies, the assumed form of the tritium for this analysis was HTO, or tritiated water vapor. Assuming a CTR operation in Morris, Illinois, surface water and ground-level air concentration values of tritium were computed for three space (or time) scales: local (50 Km of a plant), regional (up to 1000 Km of the plant), and global. (auth)

6204 (CONF-751125—7) **Advanced fusion fuels.** McNally, J.R. Jr. (Oak Ridge National Lab., Tenn. (USA)). 1975. 4p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Results of parametric studies of the reactivity of DD and D^6Li advanced fusion fuels are presented. Important control features are discussed. (auth)

6205 (UCRL—77003) **Two methods of space-time energy densification.** Sahlin, H.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jul 1975. 39p. (CONF-741178—3). Dep. NTIS $5.00.

From Conference on energy storage, compression and switching; Torino, Italy (5 Nov 1974).

With a view to the goal of net energy production from a DT microexplosion, two ideas (methods) are studied through which (separately or in combination) energy may be "concentrated" into a small volume and short period of time—the so-called space-time energy densification or compression. The advantages and disadvantages of lasers and relativistic electron-beam (E-beam) machines as the sources of such energy are studied and the amplification of laser pulses as a key factor in energy compression is discussed. The pulse length of present relativistic E-beam machines is the most serious limitation of this pulsed-power source. The first energy-compression idea discussed is the reasonably efficient production of short-duration, high-current relativistic electron pulses by the self interruption and restrike of a current in a plasma pinch due to the rapid onset of strong turbulence. A 1-MJ plasma focus based on this method is nearing completion at this Laboratory. The second energy-compression idea is based on laser-pulse production through the parametric amplification of a self-similar or solitary wave pulse, for which analogs can be found in other wave processes. Specifically, the second energy-compression idea is a proposal for parametric amplification of a solitary, transverse magnetic pulse in a coaxial cavity with a Bennett dielectric rod as an inner coax. Amplifiers of this type can be driven by the pulsed power from a relativistic E-beam machine. If the end of the inner dielectric coax is made of LiDT or another fusionable material, the amplified pulse can directly drive a fusion reaction—there would be no need to switch the pulse out of the system toward a remote target. (auth)

6206 (UCRL—77105) **Ionization, charge exchange, and secondary electron emission in the extractor of an LBL/LLL neutral beam source.** Fink, J.H.; McDowell, C.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Oct 1975. 7p. (CONF-751125—23). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Using a computer code, bombardment of the electrodes resulting from ionization, charge-exchange, and back-ion emission from the neutralizer cell is studied in the positive-ion extractor region of a Lawrence Berkeley Laboratory/Lawrence Livermore Laboratory (LBL/LLL) neutral beam source. Ion and electron trajectories are presented, grid dissipations estimated, and proposals made for future designs. (auth)

6207 (UCRL—77239) **Performance analysis of in-line direct converters for neutral beam sources.** Bender, D.J.; Barr, W.L.; Moir, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Nov 1975. Contract W-7405-Eng-48. 8p. (CONF-751125—17). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The energetics of neutral beam formation from positive ion sources with beam direct conversion is presented. Two specific converters, the immersed grid and space charge controlled configurations, are described and their performance analyzed. The space charge controlled direct converter appears to be capable of high efficiency ion energy recovery at current density levels of interest in CTR applications. Experimental verification of the performance of this converter is underway. (auth)

6208 (UCRL—77456) **Plasma focus as a pulsed power source.** Sahlin, H.; McFarland, G.; Barlett, R.; Gullickson, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Nov 1975. Contract W-7405-Eng-48. 33p. (CONF-751108—16). Dep. NTIS $5.00.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

The plasma focus is a remarkable natural phenomena that achieves significant space-time compression of both particle and field energy. Depending on the mode of operation, about 20 percent of the bank energy can be concentrated into the kinetic energy of a thin, dense, cylindrically convergent gas shell, or into a small-diameter, high-ν/γ relativistic electron burst and oppositely directed ion burst. The kinetic energy of the fast ions and electrons can exceed the applied voltage by a factor of greater than 100. The different modes of energy concentration by the plasma focus are presented and discussed both in terms of their role in the direct yield of the focus and for the case of a plasma focus supplemented by various fusionable targets. (auth)

RADIATION HAZARDS

6209 (CONF-751125—46) **Scoping studies of tritium handling in a tokamak experimental power reactor.** Cherdack, R.; Watson, J.S.; Clinton, S.D.; Fisher, P.W. (Oak Ridge National Lab., Tenn. (USA)). 1975. 9p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Tritium handling techniques in an experimental fusion power reactor (EPR) are evaluated to determine the requirements of the system and to compare different equipment and techniques for meeting those requirements. Tritium process equipment is needed to (1) evacuate and maintain a vacuum in the plasma vessel and the neutral beam injectors, (2) purify and recycle tritium and deuterium for the plasma fuel cycle, (3) recover tritium from experimental breeding modules, and (4) provide tritium containment and atmospheric cleanup. A development program is outlined to develop and demonstrate the required techniques and equipment and to permit confident design of an EPR for operation by the mid-1980s. (auth)

6210 (ORNL-TM—4777) **Experimental Engineering Section semiannual progress report (excluding reactor programs), March 1,**

1974—August 31, 1974. Scott, C.D.; Burtis, C.A.; Pitt, W.W.; Ryon, A.D.; Watson, C.D.; Watson, J.S. (comps.). (Oak Ridge National Lab., Tenn. (USA)). Jul 1975. Contract W-7405-eng-26. 263p. Dep. NTIS $16.25.

The following projects were studied: centrifugal fast analyzer development; advanced analytical techniques for wastes and biological materials; bioprocesses; water pollution; tritium processing; a tritium handling system for CTR program, and coal conversion process development. Six sections have been announced in ERDA Research Abstracts and 2 sections have been announced in Nuclear Science Abstracts. (PCS)

6211 (ORNL-TM—4777, pp 203-217) **Controlled thermonuclear processing.** Jul 1975.

In Experimental Engineering Section semiannual progress report.

Brief discussions are given on research progress during this report period for the following two topics: (1) conceptual design of a tritium handling system for Ormak F/BX, and (2) design of, and preparation for, tests of cryosorption pumping for fusion reactors. The status of the program is outlined. (MOW)

INERTIAL CONFINEMENT SYSTEMS

6212 (LA—5898-MS) **Performance of structured laser fusion pellets.** Mason, R.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-ENG-36. 17p. Dep. NTIS $4.00.

Results are presented from an extensive study of the hydroburn response of bare DT shells, inert shells, and DT-filled microballoons to ramp-like, Gaussian, and square laser pulses. Scaling laws are determined for the best pulse energy and time scale for shells, as functions of their mass, aspect ratio and initial density. The advantages of DT ice over DT gas in the microballoons are demonstrated. An equivalence rule is established between linear ramp pulses and Gaussians, and a connection is drawn between the ramps and square pulses. Projections are made, via the scaling rules, to breakeven-plus pellet designs. The scaling rules are used to recommend pulses for pellets recently imploded at LASL and KMSF. The calculated performance of these targets is shown to agree, after adjustments, with the laboratory findings. Attention is drawn to practical problem areas in structured pellet design. (auth)

6213 (LA—6063) **Laser-fusion target fabrication: application of a polymeric ablator coating to a ball-and-disk target design by the physical vapor deposition of polyethylene.** Simonsic, G.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-ENG-36. 3p. Dep. NTIS $4.00.

A technique for applying polyethylene by physical vapor deposition is described. The ball-and-disk target design requires the application of a thin film of polyethylene on the front surface of the ball and substrate upon which the ball is mounted. Disk-shaped films, typically 20-μm-diam by 1-μm-thick, are successfully applied by this method. (auth)

6214 (SAND—75-5666) **Electron-beam fusion targets.** Sweeney, M.A.; Clauser, M.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. 11p. (CONF-751130—2). Dep. NTIS $4.50.

From APS meeting; St. Petersburg, Florida, USA (10 Nov 1975).

Computer studies of the behavior of targets composed of a low-Z ablator surrounding a gold pusher are described. The targets consisted of the following: (1) an ablator, the low-Z outer part of the shell where most of the beam energy is absorbed, (2) a pusher, the high-Z inner part of the shell which accelerates inward because of the high ablator pressure, and (3) the DT fuel, which is compressed and heated to thermonuclear temperatures by the imploding pusher. Some breakeven calculations are described. (MOW)

6215 (UCRL—51929) **Some optimizations of the animal code.** Fletcher, W.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Oct 1975. Contract W-7405-Eng-48. 7p. Dep. NTIS $4.00.

Optimizing techniques were performed on a version of the ANIMAL code (MALAD1B) at the source-code (FORTRAN) level. Sample optimizing techniques and operations used in MALADOP—the optimized version of the code—are presented, along with a critique of some standard CDC 7600 optimizing techniques. The statistical analysis of total CPU time required for MALADOP and MALAD1B shows a run-time saving of 174 msec (almost 3 percent) in the code MALADOP during one time step. (auth)

6216 (UCRL—76341) **Control and data management for a large fusion laser.** Davis, J.W.; Holloway, F.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Nov 1975. 6p. (CONF-751125—15). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

SHIVA is a powerful (10-kJ 25 TW) neodymium glass laser system to be used (in 1977) for target irradiation in fusion research. SHIVA is also a development project in that it is pushing the state of the art in laser and optical technology. The present design calls for 20 parallel laser amplification chains whose light output is pointed and focused at a small (100 μ) target within a chamber from semi-equally spaced three-dimensional directions. It is probable that SHIVA will be upgraded to as many as 42 chains in the next few years. Each chain of SHIVA contains 7 high energy laser amplifiers and perhaps 20 other major optical components, many of which send and receive control and measurement information. Again future expansion may add additional elements. Each chain has also associated 10 gimbal or translation motions for beam assignment from the oscillator onto the target. (auth)

6217 (UCRL—77094(Rev.1)) **Laser fusion experiments at the Lawrence Livermore Laboratory.** Ahlstrom, H.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Oct 1975. 95p. (CONF-751130—3). Dep. NTIS $6.00.

From APS meeting; St. Petersburg, Florida, USA (10 Nov 1975).

A short review is given of some of the important dates in the experimental fusion program at Livermore. A few of the parameters of the laser systems which are being used for these experiments are mentioned. Some information about specialized diagnostics which have been developed at the Livermore Laboratory for these experiments is described. The focusing arrangements for each of the systems are discussed. Experiments both on planar targets and on targets for laser fusion are described. (auth)

6218 (UCRL—77127) **Self-generated magnetic fields in laser plasmas.** Thomson, J.J.; Max, C.E.; Attwood, D.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Aug 1975. 7p. (CONF-751131—1). Dep. NTIS $4.50.

From 7. European conference on controlled fusion; Lausanne, Switzerland (1 Nov 1975).

Megagauss-level magnetic fields were predicted theoretically and observed experimentally. The field generation due to resonance absorption of laser light and thermoelectric currents is discussed. An experiment to measure these fields by Faraday rotation of light (2660A) is described. (auth)

6219 (UCRL—77242) **High stability space frame for a large fusion laser.** Hurley, C.A.; Myall, J.O. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Nov 1975. Contract W-7405-Eng-48. 7p. (CONF-751125—9). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The Shiva laser system is a large neodymium glass laser target irradiation facility being constructed at LLL to perform laser fusion experiments. A frame is being constructed to support the large number of laser components that make up the Shiva system. Twenty laser chains composed of amplifiers, spatial filters, polarizers, rotators, and mirrors will be arranged in an optimum geometry so that each beam arrives at the target simultaneously and within alignment tolerances. This frame is capable of supporting approximately 600 individual component assemblies and maintaining a tolerance of +-4-μrad rotation between any two points over a period of 100 s. Consideration has been given to the positional stability and support of the components, the geometrical array of stacked beams with respect to the oscillator and target, the flow of utilities (e.g., power cables and cooling gas pipes), good accessibility for operation and maintenance, and adaptability for change and growth. (auth)

6220 (UCRL—77248) **Argus target chamber.** Rienecker, F. Jr.; Glaros, S.S.; Kobierecki, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Nov 1975. Contract W-7405-Eng-48. 7p. (CONF-751125—12). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A target chamber for application in the laser fusion program must satisfy some very basic requirements. (1) Provide a vacuum on the order of 10^{-6} torr. (2) Support a microscopically small target in a fixed point in space and verify its location within 5 micrometers. (3) Contain an adjustable beam focusing system capable of delivering a number of laser beams onto the target simultaneously, both in time and space. (4) Provide access for diagnostics to evaluate the results of target irradiation. (5) Have flexibility to allow changes in targets, focusing optics and number of beams. The ARGUS laser which is now under construction at LLL will have a target chamber which meets these requirements in a simple economic manner. The chamber and auxiliary equipment are described, with reference to two double beam focusing systems; namely, lenses and ellipsoidal mirrors. Provision is made

for future operation with four beams, using ellipsoidal mirrors for two-sided illumination and lens systems for tetragonal and tetrahedral irradiation. (auth)

6221 (UCRL—77249) **Compound ellipsoidal focusing system for fusion lasers.** Glaros, S.S.; Glass, A.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Nov 1975. 8p. (CONF-751125—10). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Isentropic compression of laser fusion targets requires highly uniform illumination over the entire target surface, and near normal incidence. For a two beam laser, this is best achieved using a fast catadioptric system. In designing such a system, the total thickness of refracting material must be minimized, to avoid loss of optical quality through small scale self focusing. Such a system is being fabricated for use with the ARGUS laser. It consists of a pair of nested ellipsoidal reflectors, coupled with an aspheric doublet refracting element which provides uniform illumination for the specified laser beam profile. (auth)

6222 (UCRL—77499) **Energy storage and power conditioning system for the Shiva laser.** Allen, G.R.; Gagnon, W.L.; Rupert, P.R.; Trenholme, J.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Nov 1975. Contract W-7405-Eng-48. 6p. (CONF-751125—4). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

An optimal energy delivery system for the world's largest glass laser system has been designed based on computer modeling and operation of laser hardware. Components of the system have been tested on operating lasers at LLL. The Shiva system is now under construction and will be completed in 1977. The energy supply described here will provide cost-effective, reliable power and facilitate the gathering of data in pursuit of controlled thermonuclear reactions. (auth)

6223 **Pulsed fusion of pellets using electron beams or lasers.** Beckner, E.H.; Freeman, J.R.; Gerardo, J.B.; Jones, E.D.; Toepfer, A.J.; Yonas, G. (Sandia Labs., Albuquerque, NM). pp 200-226 of In Sixth European conference on controlled fusion and plasma physics. Vol. II. Dubna, USSR; Joint Inst. for Nuclear Research (1974).

From 6. European conference on controlled fusion and plasma physics; Moscow, USSR (30 Jul 1973).

See CONF-730705—P2.

The physical and technological concepts and barriers which are important for pulsed fusion of pellets using relativistic electron beams or lasers are discussed. Recent numerical calculations of pellet dynamics are given for the two cases in order to illustrate the similarities that exist and to indicate the significant differences which can be utilized in the spatial and temporal scale of the implosions. These calculations specify the experimental parameter regime which must be achieved, with input energy ranging as low as a few hundred kilojoules in the case of electron beams and a few kilojoules in the case of lasers; power densities in the two cases tend to be comparable. An assessment of current technology, including some new results for electron beam pumped lasers, is then made for comparison. The remaining physical problems and the solutions required for achievement of fusion break-even experiments are discussed. (auth)

6224 **Super-high density laser fusion CTR.** Thiesen, A.; Zimmerman, G.; Weaver, T.; Emmett, J.; Nuckolls, J.; Wood, L. (Univ. of California, Livermore). pp 227-258 of In Sixth European conference on controlled fusion and plasma physics. Vol. II. Dubna, USSR; Joint Inst. for Nuclear Research (1974).

From 6. European conference on controlled fusion and plasma physics; Moscow, USSR (30 Jul 1973).

See CONF-730705—P2.

The basic concepts involved in laser fusion for power generation are reviewed. Brief discussions are given for each of the following topics: (1) implosion development and application, (2) thermonuclear physics, (3) implosion physics, (4) laser technology, (5) laser CTR reactors, and (6) fusion energy conversion. (MOW)

6225 **Optically gated dye cell: a high-speed shutter and pulse shaper.** Massey, G.A.; Elliott, R.A. (Oregon Graduate Center, Beaverton). *IEEE J. Quant. Electron.*; **QE-11**: No. 7, 358-364(Jul 1975).

This paper discusses characteristics of a class of devices that use a saturable absorber irradiated by an optical control pulse, or gating pulse, to alter the shape of a transmitted optical signal. Two device geometries were considered: a longitudinally gated cell, in which signal and gate beams are nearly parallel, and a transverse cell, in which the medium is bleached by a gating pulse applied at right angles to the signal beam. The longitudinal device permits synthesis of rising exponential signal pulses with arbitrary, subnanosecond time constants. The transverse geometry can provide pulses of complex shape and permits independent optimization of several device parameters. The dynamics of the saturable absorber (with particular emphasis on liquid dye systems) is analyzed in detail, and a pulse-shape synthesis procedure is outlined. Spurious nonlinear effects are considered, and an example of pulse shaping for laser-driven fusion is given. (auth)

6226 **Low-Z ablator targets for electron beam fusion.** Sweeney, M.A.; Clauser, M.J. (Plasma Theory Division-5241, Sandia Laboratories, Albuquerque, New Mexico 87115). *Appl. Phys. Lett.*; **27**: No. 9, 483-486(1 Nov 1975).

We have calculated the behavior of composite-shell DT-filled targets irradiated by constant-power ("unshaped") 1-MeV electron beam pulses. The outer part of the shell (the "ablator") is composed of a lower-Z metal than the high-density inner part (the "pusher"). The lower-Z ablator decreases the bremsstrahlung heating of the pusher. The resulting colder and denser pusher is more effective. Breakeven requires about 360 TW deposited for 8 ns in a target about 3 mm in diameter. This is less than half the power required for targets composed of a single high-density metal shell filled with DT.

COMPONENT DEVELOPMENT AND TESTING

6227 (BNWL-SA—5422) **Effects of helium implanted by tritium decay on the high temperature mechanical properties of niobium.** Atteridge, D.G.; Charlot, L.A.; Johnson, A.B.; Remark, J.F.; Westerman, R.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 19p. (CONF-751026—25). Dep. NTIS $4.50.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

The effects of helium on the high-temperature short-time tensile properties of commercial purity niobium are being determined as a first step toward attaining a better understanding of inert gas/metal matrix interactions on mechanical properties. The helium was implanted in the niobium through the use of the tritium transmutation to helium. Tritium diffused into the metal decayed to helium until the required helium concentration was reached. The tritium was then removed and the specimen tested. The tritium transmutation helium-charging method was used in this study as charging rates approaching two years of simulated fusion reactor exposure life per charging month can be achieved and the method yields uniform helium charging into standard mechanical property specimens. (auth)

6228 (CONF-750949—9) **Helium trapping in aluminum and sintered aluminum powders.** Das, S.K.; Kaminsky, M.; Rossing, T. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 8p. Dep. NTIS $4.50.

From International conference on ion beam surface layer analysis; Karlsruhe, F.R. Germany (15 Sep 1975).

The surface erosion of annealed aluminum and of sintered aluminum powder (SAP) due to blistering from implantation of 100-keV $^4He^+$ ions at room temperature has been investigated. A substantial reduction in the blistering erosion rate in SAP was observed from that in pure annealed aluminum. In order to determine whether the observed reduction in blistering is due to enhanced helium trapping or due to helium released, the implanted helium profiles in annealed aluminum and in SAP have been studied by Rutherford backscattering. The results show that more helium is trapped in SAP than in aluminum for identical irradiation conditions. The observed reduction in erosion from helium blistering in SAP is more likely due to the dispersion of trapped helium at the large Al-Al_2O_3 interfaces and at the large grain boundaries in SAP than to helium release. (auth)

6229 (CONF-751101—57) **Helium blistering of ceramic coatings on Hastelloy X and Nb—1% Zr.** Kaminsky, M.; Das, S.K.; Ekern, R. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 15p. Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The surface damage of insulating ceramic coatings on Hastelloy X and Nb—1 percent Zr held at room temperature and at 300°C was studied for both 100 keV and 250 keV helium ion irradiation for a dose range from 3.7×10^{18} to 1×10^{19} ions cm^{-2}. Blisters were observed after room temperature irradiation with both 100 keV and 250 keV helium ions. However, for irradiation at 300°C no blisters could be observed. The sharp rise in the helium permeation with temperature, observed by others for some glasses and ceramics, is thought to be responsible for this behavior. These results suggest that for the energy range studied helium

blistering has a negligible surface erosion effect on such coatings if they are operated at temperatures above 300°C. (auth)

6230 (CONF-751125—14) **Vacuum for a tokamak experimental fusion power reactor.** Moenich, J.S.; Fasolo, J.A.; Stevens, H.C. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 6p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A preliminary study was made of the vacuum system requirements for a D-T burning TEPR with major radius R = 6.25 m and plasma radius a = 2.1 m. Approximate requirements for the neutral injector vacuum system have been determined as functions of neutral beam power for a one-component, 180 keV D^0 beam derived from D^+. For the 40 MW reference design D^0 beam, the total injector gas load varies from approximately 500 to approximately 800 Torr-l/s as the assumed ion source gas efficiency varies from 40 to 25 percent. The torus or plasma containment vessel has 711 m^3 of volume and 592 m^2 of surface area. Material selection for the first wall will affect the total gas load available to be pumped. The toroidal pumping system must be able to reduce the pressure after the burn or fusion cycle from 10^{-3} Torr to 10^{-6} Torr or less in 10 to 15 s. Furthermore, before each experimental run, or possibly more often, this pumping system must be capable of evacuating the entire volume down to 1×10^{-6} Torr or less to assure a reasonably contamination free plasma. (auth)

6231 (CONF-751125—40) **Magnetic shielding system for the tokamak experimental power reactor.** Marcus, F.B.; Peng, Y.K.M.; Dory, R.A.; Moore, J.R. (Oak Ridge National Lab., Tenn. (USA)). 1975. 4p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A poloidal field system is proposed for superconducting tokamaks which magnetically shields the toroidal field coil windings from pulsed fields and reduces the plasma inductive requirements. The principal elements of the system are a primary air core winding and a shield-vertical-field winding. The properties of the system are investigated using computer codes for MHD equilibrium, inductances, and fields. (auth)

6232 (CONF-751125—43) **Mechanical engineering problems in the TFTR neutral beam system.** Cannon, D.D.; Bryant, E.H.; Johnson, R.L.; Kim, J.; Queen, C.C.; Schilling, G. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1975. 13p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A conceptual design of a prototype beam line for the TFTR Neutral Beam System has been developed. The basic components have been defined, cost estimates prepared, and the necessary development programs identified. Four major mechanical engineering problems, potential solutions and the required development programs are discussed. (auth)

6233 (CONF-751125—68) **First wall coatings.** Simpkins, J.E. (Oak Ridge National Lab., Tenn. (USA)). 1975. 3p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

As impurity problems become more significant, the selection of a suitable first wall material becomes more important. Many of the candidates are impractical either because they are difficult to fabricate or do not possess adequate strength. An alternate solution is a composite wall consisting of a suitable coating on a substrate chosen for its strength and ease of fabrication. Various techniques have been investigated for depositing a variety of candidate materials onto 304 L stainless steel. Thick coatings of several of these materials have been satisfactorily deposited utilizing ion plating. This technique is described in some detail. (auth)

6234 (GA-A—13665) **Sputtering measurements on CTR materials using Auger electron spectroscopy.** Smith, J.N. Jr.; Meyer, C.H. Jr.; Layton, L.K. (General Atomic Co., San Diego, Calif. (USA)). 13 Oct 1975. Contract E(04-3)-167. 13p. (CONF-751101—58). Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The sputter yield of Nb, W, C, and Ag by Ar^+ in the energy range from 0.5 to 1.5 keV was measured. In addition, the sputter yield for W, C and Ag by H^+ at 11.0 keV has been determined. With the exception of carbon, the data are in general agreement with earlier work. For carbon, some discrepancies between the present work and earlier studies are found. It is suggested that major factors contributing to these discrepancies are structural and/or chemical in nature. (auth)

6235 (ORNL—5050, pp 79-81) **Controlled thermonuclear program.** Oct 1975.

In Chemical Technology Division annual progress report for period ending March 31, 1975.

Brief discussions are given for the following four areas of research: (1) tritium handling system for an experimental fusion power reactor, (2) preparation for tests of cryosorption pumping for fusion reactors, (3) tritium sorption studies, and (4) tritium sorption in Li—Al and Li—Bi alloys. (MOW)

6236 (SAND—75-8679) **Helium re-emission and surface deformation in niobium during multiple temperature helium implantation.** Bauer, W.; Thomas, G.J. (Sandia Labs., Livermore, Calif. (USA)). Oct 1975. Contract AT(29-1)-789. 17p. (CONF-750949—8). Dep. NTIS $4.50.

From International conference on ion beam surface layer analysis; Karlsruhe, F.R. Germany (15 Sep 1975).

In previously published work, it was shown that helium implantation at high doses at temperatures of 400—700°C gave rise to relatively low helium re-emission and that the dominant mode of surface deformation consisted of flaking. On the other hand, during implantation at 1000°C and above, the helium re-emission approached 100 percent and a very stable mode of surface deformation consisting of holes was created. For CTR first wall applications, the high temperature case appears to be very favorable whereas the low temperature case is unacceptable. Helium re-emission and surface deformation in the low temperature range after high temperature exposure was studied. It was found that essentially no additional surface deformation occurred during low temperature helium implantation when the sample had been pre-exposed at 1200°C. Apparently the porous structure created during helium implantation at 1200°C gives rise to a significantly different helium sink distribution and this accounts for the radically different low temperature implantation behavior. (auth)

6237 (UCID—16940) **DT fusion neutron irradiation of BPNL graphite irradiation capsule and LLL niobium tensile specimens.** MacLean, S.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Aug 1975. Contract W-7405-Eng-48. 8p. Dep. NTIS $4.00.

Test procedures for irradiating graphite and niobium tensile specimens with 14-MeV neutrons from the LLL Rotating Target Neutron Source are outlined. No test results are given. (MOW)

6238 (UCID—16941) **DT fusion neutron irradiation of WRDC electron microscopy samples, LLL supraeil samples, and LLL aluminum tensile specimens.** MacLean, S.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Sep 1975. Contract W-7405-Eng-48. 8p. Dep. NTIS $4.00.

The experimental parameters using 14-MeV neutrons from the LLL Rotating Target Neutron Source are described for the above specimens are presented. No results are given. (MOW)

6239 (UCID—16942) **DT fusion neutron irradiation of LLL copper tensile specimens at 210°C.** MacLean, S.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Sep 1975. Contract W-7405-Eng-48. 8p. Dep. NTIS $4.00.

Test procedures for irradiating five copper tensile specimens with 14-MeV neutrons from the LLL Rotating Target Neutron Source are outlined. No test results are given. (MOW)

6240 (UCRL—77153) **Depth profiling of tritium by neutron time-of-flight.** Davis, J.C.; Anderson, J.D.; Lefevre, H.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1975. Contract W-7405-Eng-48. 19p. (CONF-751026—23). Dep. NTIS $4.50.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

A method was developed to measure the depth profile of tritium implanted or absorbed in materials. The sample to be analyzed is bombarded with a pulsed proton beam and the energy of neutrons produced by the T(p,n) reaction is measured by the time-of-flight technique. From the neutron energy the depth in the target of the T atoms may be inferred. A sensitivity of 0.1 at. percent T or greater is possible. The technique is non-destructive and may be used with thick or radioactive host materials. Samples up to 20 μm in thickness may be profiled with resolution limited by straggling of the proton beam for depths greater than 1 μm. Deuterium depth profiling has been demonstrated using the D(d,n) reaction. The technique has been used to observe the behavior of an implantation spike of T produced by a 400 keV T^+ beam stopping at a depth of 3 μm in 11 μm thick layers of Ti and TiH. The presence of H in the Ti lattice is observed to inhibit the diffusion of T through the lattice. Effects of the total hydrogen concentration (H + T) being forced above stoichiometry at the implantation site are suggested by the shapes of the implanation spikes. (auth)

6241 (UCRL—77226) **2XIIB vacuum vessel: a unique design.** Hibbs, S.M.; Calderon, M.O. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Nov 1975. Contract W-7405-Eng-48. 6p. (CONF-751125—29). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The 2XIIB mirror confinement experiment makes unique demands on its vacuum system. The confinement coil set encloses a cavity whose surface is comprised of both simple and compound curves. Within this cavity and at the core of the machine is the operating vacuum which is on the order of 10^{-9} Torr. The vacuum container fits inside the cavity, presenting an inside surface suitable for titanium getter pumping and a means of removing the heat load imposed by incandescent sublimator wires. In addition, the cavity is constructed of nonmagnetic and nonconducting materials (nonmetals) to avoid distortion of the pulsed confinement field. It is also isolated from mechanical shocks induced in the machine's main structure when the coils are pulsed. This paper describes the design, construction, and operation of the 2XIIB high-vacuum vessel that has been performing successfully since early 1974. (auth)

6242 (UCRL—77234) **Neutral beam injection in 2XIIB.** Hibbs, S.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Nov 1975. 6p. (CONF-751125—26). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Integrated into the operation of the 2XIIB controlled fusion experiment is a 600-A, 20-keV neutral injection system: the highest neutral-beam current capacity of any existing fusion machine. This paper outlines the requirements of the injection system and the design features to which they led. Both mechanical and electrical aspects are discussed. Also included is a brief description of some operational aspects of the system and some of the things we have learned along the way, as well as a short history of the most significant developments. (auth)

6243 (UCRL—77236) **Beam-line cryopump.** Duffy, T.J.; Oddon, L.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Nov 1975. Contract W-7405-Eng-48. 5p. (CONF-751125—22). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A cryopumping module using metallic surfaces at liquid helium temperature for condensation of hydrogen and deuterium gas has been constructed. This pump, a prototype of four units which will provide pumping for the Livermore 200 kV test stand, will be used to verify the concept and establish engineering parameters. Upon completion of engineering tests and evaluation the pump will be installed in an operating beam line. The design point pumping capacity is 80,000 liters per second for hydrogen and deuterium at 10^{-4} torr based on sticking coefficients of 0.15 and 0.25, respectively. Both the liquid helium temperature pumping surface and the liquid nitrogen temperature radiation shields are constructed of quilted double wall cylindrical shells. The pumping shell dimensions are 1.5 meters dia. x 0.6 meters long. Cryogen circulation is convection current driven in both cases. Liquid helium is supplied from an overhead Dewar through bayonet coupling. In the 200 kV beam line, pumping modules will be supplied via transfer lines from a central Dewar. Voltage standoff will be accomplished in the transfer lines. (auth)

6244 (UCRL—77238) **Mechanical design for neutral beam injection.** Pittenger, L.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Nov 1975. Contract W-7405-Eng-48. 6p. (CONF-751125—24). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

At the Lawrence Livermore and Berkeley Laboratories two major neutral beam system designs were developed, the High Voltage Test Stand (HVTS) and a conceptual system for the Two Component Tokamak-Toroidal Fusion Test Reactor (TCT-TFTR). The HVTS was designed for flexibility in performing a wide variety of tests, while the TCT-TFTR beam line was designed to satisfy particular requirements for target-plasma operation. Both designs make use of condensation cryopumping to handle very high gas loads. The HVTS design involves high-voltage isolation techniques of cryogenic and other systems. The TCT-TFTR design requires optimization of pumping and other systems. It is to be expected that experience gained from design and operation of the HVTS systems will be of value to the final design of TCT-TFTR and to the engineering of future fusion reactors. (auth)

6245 (UCRL—77357(Rev.1)) **DT fusion neutron radiation strengthening of copper and niobium.** Mitchell, J.B.; Van Konynenburg, R.A.; Echer, C.J.; Parkin, D.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Oct 1975. 50p. (CONF-751026—32). Dep. NTIS $5.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

The initial results of a comparative study of the radiation strengthening and damage structures produced in Cu and Nb by D-T fusion and fission reactor neutrons are described. The radiation strengthening produced by a given fluence of fusion neutrons above about 10^{17}n/cm^2 is equal to that produced by a fluence of fission reactor neutrons (E greater than 0.1 MeV) ten times as great. This difference is about twice as large as would be expected if the strengthening scaled with damage energy or dpa. Initial transmission electron microscopy observations of the damage structures in fusion and fission reactor neutron irradiated copper indicate that the same type of primary structural defects, vacancy and interstitial point defect clusters and small dislocation loops with a/3 (111) and a/2 (110) Burgers vectors, are produced in both cases. The difference in the radiation strengthening produced by fusion and fission reactor neutrons in Cu appears to result from a substantially greater rate of accumulation of damage, in the form of point defect clusters, during irradiation with fusion neutrons than during irradiation with fission reactor neutrons plus a significant difference in the size and spatial distributions of the damage clusters. (auth)

GENERAL AND MISCELLANEOUS

6246 (RLO—2225-32) **University-ERDA Laboratory Cooperative Program. Annual progress report.** (Northwest Coll. and Univ. Association for Science, Richland, Wash. (USA)). 10 Nov 1975. 18p. Dep. NTIS $4.50.

The distribution of NORCUS appointments to colleges and universities for the summer of 1973, 1974, and 1975 is given. Responses from participants in the program are included. (BJG)

6247 **MICROWAVE SYMPOSIUM. 1974 IEEE S-MTT INTERNATIONAL CONFERENCE HELD AT ATLANTA, GEORGIA, JUNE 12—14, 1974.** Gaylord, T.K. (ed.). IEEE Cat. No. 74CH0838-3MTT. New York; United States of America (USA); Institute of Electrical and Electronics Engineers, Inc. (1974). 391p. (CONF-740610—). $20.00.

From S-MTT international microwave symposium; Atlanta, Georgia, USA (12 Jun 1974).

Abstracts of two items concerning hazards of microwaves were included in ERDA Research Abstracts. (SFL)

MANAGEMENT

6248 (CONF-751047—1) **Pre-employment screening of workers for heart problems.** Garrett, A.S. Jr. (Oak Ridge National Lab., Tenn. (USA)). 1975. 10p. Dep. NTIS $4.50.

From Industrial occupational health conference; Memphis, Tennessee, USA (30 Oct 1975).

Employee selection practices at ORNL are reviewed. It is pointed out that attempts are made to avoid the rejection of applicants with handicaps including cardiovascular diseases. (CH)

6249 (CONF-751047—2) **Return to work from myocardial infarction.** Garrett, A.S. (Oak Ridge National Lab., Tenn. (USA)). 1975. 9p. Dep. NTIS $4.50.

From Industrial occupational health conference; Memphis, Tennessee, USA (30 Oct 1975).

Methods for the rehabilitation of patients following myocardial infarction so that they may return to work are discussed. Both physical and psychological aspects of the rehabilitation program are discussed. (CH)

6250 (LA—5900-MS) **Publications of LASL research, 1974.** Kerr, A.K. (Los Alamos Scientific Lab., N.Mex. (USA)). May 1975. Contract W-7405-ENG-36. 310p. Dep. NTIS $7.60.

This bibliography includes Los Alamos Scientific Laboratory reports, papers released as non-Los Alamos reports, journal articles, books, chapters of books, conference papers (whether published separately or as part of conference proceedings issued as books or reports), papers published in congressional hearings, theses, and U. S. patents. Publications by LASL authors which are not records of Laboratory-sponsored work are included when the Library becomes aware of them. The entries are arranged in sections by broad subject categories; within each section they are alphabetical by title. The following subject categories are included: aerospace studies; analytical technology; astrophysics; atomic and molecular physics, equation of state, opacity; biology and medicine; chemical dynamics and kinetics; chemistry; cryogenics;

crystallography; CTR and plasma studies; earth science and engineering; energy (non-nuclear); engineering and equipment; EPR, ESR, NMR studies; explosives and detonations; fission physics; health and safety; hydrodynamics and radiation transport; instruments; lasers; mathematics and computers; medium-energy physics; metallurgy and ceramics technology; neutronic and criticality studies; nuclear physics; nuclear safeguards; physics; reactor technology; solid state science; and miscellaneous (including Project Rover). Author, numerical and KWIC indexes are included. (RWR)

6251 (NCSR-R—1) **National Centre of Systems Reliability and some aspects of its future activities.** Bourne, A.J. (UKAEA National Centre of Systems Reliability, Culcheth). Dec 1974. 16p. Dep. NTIS (US Sales Only) $4.50.

The National Centre of Systems Reliability (NCSR) has been set up to enhance the work of the Systems Reliability Service (SRS), which during its four years of operation by the UKAEA has offered to industry expertise in the quantification of reliability of systems in various technological applications. An outline is presented of the background to the establishment of the NCSR, including a brief summary of the work of the SRS. Certain aspects of the future activities of the NCSR, particularly in relation to research and collaboration with universities, are discussed. (UK)

MATHEMATICS AND COMPUTERS

6252 (AERE-R—6469) **Fortran subroutine for unconstrained minimization, requiring first derivatives of the objective function.** Powell, M.J.D. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jul 1970. 45p. Dep. NTIS (US Sales Only) $5.00. UK 4s.6d.

A Fortran subroutine is described and listed for calculating the least value of a function of several variables, F(x_1,x_2,...,x/sub n/) say. The user must provide a subroutine to calculate F(x_1,x_2,... ,x/sub n/) and the first derivative vector of the objective function for any (x_1,x_2,...,x/sub n/). The method used is the new one proposed by Powell AERE-TP-393, which has the advantage that convergence is guaranteed in theory, even if no good initial estimate of the required vector of variables is available. The convergence criterion is that the algorithm finishes when its search to reduce F(x_1,x_2,...,x/sub n/) gives a point at which the magnitude of the first derivative is less than a prescribed positive tolerance. Numerical examples and the convergence theorems (Powell, op. cit.) suggest that the new subroutine compares favorably with the other general methods for solving unconstrained optimization problems. 2 tables (auth)

6253 (BNL—20645) **Logical and physical resource management in the common node of a distributed function laboratory computer network.** Stubblefield, F.W. (Brookhaven National Lab., Upton, N.Y. (USA)). Nov 1975. 11p. (CONF-751116—18). Dep. NTIS $3.50.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

A computer network architecture consisting of a common node processor for managing peripherals and files and a number of private node processors for laboratory experiment control has been previously described. The mode of communication between the nodes is that of the transaction. The procedures and data structures used to manage both logical and physical resources required during processing of a transaction by the common node are discussed. 4 figures, 4 tables. (auth)

6254 (BNL—20666) **Task scheduler and service subsystem for the common node of a distributed function laboratory computer network.** Stubblefield, F.W.; Dimmler, D.G. (Brookhaven National Lab., Upton, N.Y. (USA)). Nov 1975. 12p. (CONF-751116—14). Dep. NTIS $4.50.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

In a functionally distributed computer system, the system function is partitioned into less complex functions which reside at decreasing functional hierarchy levels. At some point in the partitioning process, all software and hardware required to implement an identified function are confined to a node of the system. The type of hardware elements and the form of the software required at the node are determined by the node function. This principle is illustrated in the case of a task scheduler for the common node of a distributed function laboratory computer system having a star-like configuration. 2 figures, 2 tables. (auth)

6255 (BNL—20667) **Continuous sharing of a record-oriented output device within a distributed function laboratory computer network.** Stubblefield, F.W. (Brookhaven National Lab., Upton, N.Y. (USA)). Nov 1975. 13p. (CONF-751116—17). Dep. NTIS $4.50.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

An attempt to partition along functional lines a computer system for control of and data collection from a set of laboratory experiments leads to the notion of sharing of peripheral devices. Peripheral devices can be shared in two fundamentally different ways, reserved for discrete periods of time or continuously shared. The design and implementation of a subsystem to handle the continuous sharing of a record-oriented device is discussed. 4 figures, 1 table. (auth)

6256 (CERN—75-15) **Terminals for the interactive input and editing of bibliographic records on the PDP-11 computer in the CERN library.** Van Praag, A. (European Organization for Nuclear Research, Geneva (Switzerland)). 13 Nov 1975. 64p. Dep. NTIS (US Sales Only) $5.50.

As part of the Library Mechanization Project, special computer terminals were designed and built for the input and display of a wide range of characters, including Greek letters and mathematical symbols. Each terminal consists of a novel 7-bank keyboard together with two Tektronix 611 storage-tube displays, and there are four terminals connected to a PDP-11/20 computer. After an outline of the hardware for the terminal system, this report gives accounts of the computer interface, display driver, matrix character generator, keyboard, programable clock, and address comparator. More detailed descriptions of the circuits, the signal formats, and a complete set of schematic diagrams are given as appendices. 63 figures (auth)

6257 (CNRS-CPT—76-P-602) **Spectral subspaces and their applications to automorphism groups.** Olesen, D. (Centre National de la Recherche Scientifique, 13 - Marseille (France). Centre de Physique Theorique). Mar 1974. 60p. Dep. NTIS (US Sales Only) $5.00.

A survey of the theory of spectra and spectral subspaces of group representations in an abstract Banach space setting is given. This theory is applied to groups of automorphisms of operator algebras and some important results of interest to mathematical physicists are proved. (BJG)

6258 (CONF-750482—1) **Basic interrupt and command structures and applications.** Davies, R.C. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1974. 5p. Dep. NTIS $4.00.

From DECUS symposium; Miami, Florida, USA (15 Apr 1975).

Interrupt and command structures of a real-time system are described through specific examples. References to applications of a real-time system and programing development references are supplied. (auth)

6259 (CONF-750482—3) **Multiple-task real-time PDP-15 operating system for data acquisition and analysis.** Myers, W.R. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1974. 4p. Dep. NTIS $4.00.

From DECUS symposium; Miami, Florida, USA (15 Apr 1975).

The RAMOS operating system is capable of handling up to 72 simultaneous tasks in an interrupt-driven environment. The minimum viable hardware configuration includes a Digital Equipment Corporation PDP-15 computer with 16384 words of memory, extended arithmetic element, automatic priority interrupt, a 256K-word RS09 DECdisk, two DECtape transports, and an alphanumeric keyboard/typer. The monitor executes major tasks by loading disk-resident modules to memory for execution; modules are written in a format that allows page-relocation by the monitor, and can be loaded into any available page. All requests for monitor service by tasks, including input/output, floating point arithmetic, request for additional memory, task initiation, etc., are implemented by privileged monitor calls (CAL). All IO device handlers are capable of queuing requests for service, allowing several tasks "simultaneous" use of all resources. All alphanumeric IO (including the PC05) is completely buffered and handled by a single multiplexing routine. The floating point arithmetic software is re-entrant to all operating modules and includes matrix arithmetic functions. One of the system tasks can be a "batch" job, controlled by simulating an alphanumeric command terminal through cooperative functions of the disk handler and alphanumeric device software. An alphanumeric control sequence may be executed, automatically accessing disk-resident tasks in any prescribed order; a library of control sequences is maintained on bulk storage for access by the monitor. (auth)

6260 (CONF-751011—3) **AESOP - XIII. Experiences with performance measurement at Argonne National Laboratory.** Snider, D.R. (Argonne National Lab., Ill. (USA)). Oct 1975. Contract W-31-109-Eng-38. 26p. Dep. NTIS $5.00.

From 13. AESOP meeting; Chicago, Illinois, USA (22 Oct 1975).

The Central Computing Facility at ANL is very briefly described. Attention is then directed to system performance evaluation activities of the Systems Group. The primary aim is to measure the operational characteristics of the computer system and apply the results to the system so as to improve its efficiency. Emphasis is on the NEUROTRON hardware monitor and some of its applications. 17 figures. (RWR)

6261 (CONF-751110—1) **Biomedical Computing Technology Information Center (BCTIC). Focus for the sharing of computer programs and technology in biomedicine.** Maskewitz, B.F.; McClain, W.J.; Henne, R.L. (Oak Ridge National Lab., Tenn. (USA)). 1975. 12p. Dep. NTIS $4.00.

From 5. national conference on society of computer medicine; Chicago, Illinois, USA (12 Nov 1975).

The Biomedical Computing Technology Information Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee, is organized to make its information quickly available to those who telephone or come to visit. The aim of the Center is to provide the most up-to-date information possible concerning computer applications in medicine and other biological studies. (CH)

6262 (CONF-751113—6) **Distribution of the skewness and kurtosis statistics in general.** Bowman, K.O.; Shenton, L.R. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Computer Sciences Div.). 1975. 29p. Dep. NTIS $5.00.

From 1. ERDA statistical symposium; Los Alamos, New Mexico, USA (3 Nov 1975).

An attempt is made to find moments of sample moments which result in Taylor-series developments in powers of the inverse sample size. (26 references) (BJG)

6263 (COO—2383-0024) **Numerical errors in sparse linear equations.** Gear, C.W. (Illinois Univ., Urbana (USA). Dept. of Computer Science). May 1975. Contract AT(11-1)-2383. 8p. Dep. NTIS $4.50.

Important classes of problems such as network analysis lead to very sparse unsymmetric systems of linear equations of a high order. Frequently a Gauss elimination technique is used to form the LU decomposition with some form of pivoting being done to reduce fill-in and to preserve some numerical stability. The purpose of this note is to show that an error bound can be obtained of the same size as that obtained when analyzing a p by p system, where p is the maximum number of non-zeros in rows or columns of the decomposed matrix. (auth)

6264 (COO—2383-0028) **Annual progress report ending May 20, 1975.** (Illinois Univ., Urbana (USA). Dept. of Computer Science). Apr 1975. 384p. (UIUCDCS-APR—75). Dep. NTIS $22.25.

Research performed in the Information Engineering Laboratory of the Department of Computer Science is described. The beginning of the period coincides with the first thrust to prove the practicability of nonweighted binary representations used in periodically recurring approximations (BURSTs). The main emphasis during the middle period was the hardware realization of some of the fundamental BURST processing ideas. The main event during the last period was the successful completion of the world's first purely digital AM receiver. The material is arranged as follows: hardware research (Navy), hardware research (various), computer systems research, switching theory and logical design, machine and software organization studies, aspects of combinatorial computing, theory of digital computer arithmetic, ACSES: the automated computer science education system on PLATO, machine intelligence and perception, (AQVAL project), statistics and statistical applications, mesh research project, iterative solution of symmetric and nonsymmetric systems with dynamic estimation of parameters, specification and preliminary design of an array processor, and general information (personnel, bibliography, colloquia, drafting, shop's production). (RWR)

6265 (DP-MS—75-108) **Software performance and evaluation: mixed applications.** Honeck, H.C. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 8p. (CONF-751011—4). Dep. NTIS $4.50.

From 13. AESOP meeting; Chicago, Illinois, USA (22 Oct 1975).

The importance of performance factors other than hardware utilization in the optimization of software performance is addressed. The comments apply to both business systems and production scientific systems, but not to research scientific systems. It is realized that many performance factors cannot be measured and that value judgments must be made; nevertheless, performance evaluation must be done. (RWR)

6266 (JAERI-M—5980) **Magnetic-tape base system for computer USC-3. MTEDIT: one of the programs and usage of the system.** Kawarasaki, Y. (Japan Atomic Energy Research Inst., Tokyo). Feb 1975. 39p. (In Japanese). INIS.

The magnetic-tape base system has been prepared for use in computer USC-3 and its peripherals. The soft-ware system consists of four independent programs, i.e. [LOADFM], [STORTM], [MT''ST] and [MTEDIT]; the former three were reported previously. In this system, experimental data and the processing programs recorded on magnetic tapes can be handled in common in a unified FORMAT. [MTEDIT] is first described in detail, including its specification. The function of each program and the interrelations between respective programs are then briefed. The manual on usage of the programs is presented. Examples of application of the programs are also given. (auth)

6267 (KFK-PDV—50) **Microprocessors and multiprocessor networks. PDV workshop, Munich, December 6-7, 1974.** Birck, H.; Faerber, G.; Halling, H.; Heger, D.; Holler, E.; Patz, M.; Steusloff, H.; Walze, H. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). Aug 1975. 122p. (In German). (CONF-741258—). Dep. NTIS (US Sales Only) $6.50.

From PDV workshop on microprocessors and multiprocessor networks; Munich, F.R. Germany (5 Dec 1974).

The essentials of single papers presented at the PDV workshop on "Microprocessors and Multiprocessor Networks" held on December 5 and 6, 1974, in Munich are given. The most important features of microprocessors and microcomputer components available today are listed and briefly described. In addition, typical application schemes are presented. 39 figures, 6 tables. (auth)

6268 (KFKI—75-60) **Concept of variety in the theory of categories.** Nemeti, I.; Gergely, T.; Pasztor, A. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). 1975. 39p. Dep. NTIS (US Sales Only) $5.00.

The present study introduces a general concept of variety in the theory of categories and gives methods which generalize Mal'cev' results [Algebraic Systems, Springer-Verlag, New York, 1973], on the one hand, and facilitate the universal-algebraic handling of these results, on the other hand. (auth)

6269 (LA—6131—MS) **Subcycling of control codes and mesh computations.** Lee, C.E. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1975. Contract W-7405-Eng-36. 11p. Dep. NTIS $4.00.

Several methods of subcycling coupled codes and mesh cell calculations are investigated for time-dependent problems. The probability P(x) of a method running $1/x$, $0 < x < 1$ times faster than the locked-in mode is estimated. In all cases examined it is found that significant computer time savings (factors of ~ 3-10) can be realized by using subcycling of codes and/or mesh cells. (auth)

6270 (LA—6138-MS) **Algorithm for the recognition of typed two-dimensional mathematical expressions.** Wells, M.B. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1975. Contract W-7405-Eng-36. 29p. Dep. NTIS $4.00.

An algorithm is given which translates two-dimensional mathematical expressions such as subscripting and displayed division that were prepared using a keyboard input device into a string form suitable for input to a classical compiler. The algorithm allows reasonably general forms, yet is sufficiently simple to be practically applicable today. It may be written as a preprocessor to an existing compiler in order to improve the readability of an existing language. The algorithm is presented in a version of the Madcap language, a language which itself allows two-dimensional constructions.

6271 (LA-UR—75-1653) **Structure-formers in programming languages.** Morris, J.B. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 11p. (CONF-760103—1). Dep. NTIS $4.50.

From 3. ACM Sigact-Sigplan symposium on principles of programming languages; Atlanta, Georgia, USA (19 Jan 1976).

The language feature of the structure-former is isolated, and attention is drawn to it as a language feature in its own right. Structure-formers are discussed within the framework of the model programming language, a language under development, primarily for the purpose of studying data abstraction. (JFP)

6272 (LA-UR—75-1990) **Performance of measurement tools and evaluation of scientific software.** Rudsinski, L.E.; Melendez, K.J.; Fullerton, L.W.; Marusak, A.; McGirt, F. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 14p. (CONF-751011—2). Dep. NTIS $4..50.

From 13. AESOP meeting; Chicago, Illinois, USA (22 Oct 1975).

In early 1971, the usual interest of the Los Alamos Scientific Laboratory (LASL) in efficient use of computers was given special emphasis. The development of performance measurement tools and establishment of a computer program optimization project were the direct result of this concern. These experiences led to the design and implementation of new performance tools that will enable evaluation of both the program and the algorithm. The design, implementation, and use of these tools are discussed. (4 figures) (auth)

6273 (LA-UR—75-2013) **Capacitance matrix technique.** Buzbee, B.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 10p. (CONF-750987—1). Dep. NTIS $4.50.

From Symposium on sparse matrix computations; Argonne, Illinois, USA (9 Sep 1975).

The capacitance matrix technique is a modification method that is associated with elliptic difference systems and is characterized by a modification of rows. A unified development of this technique where the preprocessing phase on an n by n mesh requires $O(pn^2 + p^3)$ operations is presented. The capacitance method and the matrix decomposition Poisson solver are developed. (BJG)

6274 (LBL—4233) **Hardware and system architecture for a very large database.** Healey, R.; Heckman, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 4p. (CONF-750974—1). Dep. NTIS $4.00.

From Conference on very large databases; Farmingham, Massachusetts, USA (22 Sep 1975).

Practical experience in structuring a large amount of data is described. The architecture for structuring the database for online devices and making the retrieval as efficient as possible is explained. (BJG)

6275 (LTSS—304(Ed.1)(Rev.4)) **Livermore time-sharing system. Part IV. Library files. Chapter 304. ORDERLIB subroutine library.** Carpenter, E.; Solbeck, S.V.; Dusenbury, K. (comps.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Jun 1973. 76p. Dep. NTIS $6.00.

Various revised pages for chapter 304, ORDERLIB Subroutine Library, of the manual on the Livermore time-sharing system are given. (RWR)

6276 (ORNL-TM—5065) **Programming practices and computer code development.** Vondy, D.R. (Oak Ridge National Lab., Tenn. (USA)). Dec 1975. Contract W-7405-eng-26. 63p. Dep. NTIS $5.45.

This report presents recommendations to programers developing computer codes. These are of special importance in effort on those codes which will be used at other installations, on other computers. Many of the code exchange problems are addressed. Certain local routines are described which perform special tasks, many of which are not possible within the scope of the Fortran language. (auth)

6277 (ORNL-TM—5079) **Disk/DECtape monitor for the TD8E.** Bell, P.R.; Dillon, R.S.; Beasley, B.E. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 33p. Dep. NTIS $4.00.

An efficient and convenient monitor system to be used with the low-cost TD8E DECtape unit was developed by modifying the existing DEC 4K monitor system and several system programs. The system will operate in an 8K or larger PDP 8/E computer, will support two tape drives, and can load and save programs from all available memory. The operation is the same as in the usual TC01/08 DECtape system. (auth)

6278 (ORNL-TM—5177) **Three computer codes of general use in x-ray crystallography.** Yakel, H.L. (Oak Ridge National Lab., Tenn. (USA)). Jan 1976. Contract W-7405-eng-26. 157p. Dep. NTIS $7.75.

This report contains the FORTRAN listings and sample problem inputs and outputs for three programs of general use in x-ray diffraction analyses. The programs calculate and plot stereographic projections, Laue patterns, and Debye—Scherrer patterns for general crystal systems and, in the case of the third, for known crystal structures. 16 figures. (auth)

6279 (RISO-M—1828) **FORSC, a language for structured coding in FORTRAN.** Soee Hoejberg, K. (Danish Atomic Energy Commission, Risoe. Research Establishment). Nov 1975. 17p. Dep. NTIS (US Sales Only) $3.50.

FORSC, a FORTRAN structure coder, is an extension to FORTRAN, and is intended for use on PDP8 type computers. It consists of a set of instructions that can be used together with FORTRAN IV statements to create a structured program. FORSC is intended as an aid in the standardization of programming techniques. The object program is translated to a homogeneous FORTRAN IV program by means of a macro processor, 8BAL. FORSC produces comments which emphasize the structure of the FORTRAN program. A generalized IF instruction is proposed, which can be used in the same way as a CASE instruction. Other instructions included are WHILE, UNTIL, FOR and LOOP with exit. The current version of macro definitions is developed on and for a PDP8/I with 16 k core memory and OS/8 monitor system. This version allows nesting of any instruction with up to five levels of the same instruction type. (auth)

6280 (SAND—74-8221) **Engineering Mathematics Refresher Course. Part II.** Soderstrand, M.A. (Sandia Labs., Livermore, Calif. (USA)). Oct 1975. Contract AT(29-1)-789. 177p. Dep. NTIS $7.60.

This is the second of two six-week Engineering Mathematics Refresher Courses to be given in Sandia Laboratories in Livermore, California. The goal of these courses is to sharpen the student's abilities in areas which may have become rusty over the years. This second six-week course consists of one week each of complex variables; vector, matrix, and tensor techniques; systems of differential equations; infinite series and Fourier analysis; numerical techniques and computer analysis; probability and statistics. Weekly assignments, homework problems, examinations, and lecture notes are included in this text. In addition, reading in other textbooks and optional or reference reading are also assigned. (auth)

6281 (SAND—75-5884) **QMESH mesh generation package.** Jones, R.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 14p. (CONF-751208—1). Dep. NTIS $4.50.

From Conference on software for partial differential equations; Moffett Field, California, USA (8 Dec 1975).

A package of five programs centering around the highly flexible, powerful, two-dimensional mesh generation program QMESH is presented. Together, the five programs provide a tool for generation, bandwidth minimization, and display of meshes with Q4 or Q8 elements. The primary purpose of the package is generation of input for finite element analysis programs. (auth)

6282 (SAND—75-8297) **MEDIA8: a program to read PDP-8 DECtapes on a PDP-11.** Jones, H.D. (Sandia Labs., Livermore, Calif. (USA)). Nov 1975. Contract AT(29-1)-789. 20p. Dep. NTIS $4.50.

MEDIA8 is a PDP-11 minicomputer program which reads data from a DECtape prepared on a PDP-8, does conversions of the data into a format compatible with the PDP-11, and then writes the converted data out to an RT-11 device or permanent file. The conversions allowed by the program include two kinds of character string conversions, integer and floating point number conversions (both for single precision and double precision numbers), and a straight "no conversion" conversion. The conversion routines are tied together by a simplified calling method that allows repeated conversion requests to be specified in an abbreviated form similar to the FORMAT statement in FORTRAN. The program is currently being used on SLL's media conversion minicomputer to enable users of PDP-8 minicomputers easy access to the CDC 6600 computer for data reduction problems. (auth)

6283 (SU—326-P30-42) **Relation between quadratic termination and convergence NCE properties of minimization algorithms.** Stoer, J. (Stanford Univ., Calif. (USA). Dept. of Computer Science). Aug 1975. Contract E(04-3)326. 104p. Dep. NTIS $5.50.

Many of the existing algorithms for solving minimization problems of the form min f(x) = f(anti x), f:R/sup n/ yields R, are devised such that they terminate with the optimal solution anti x within at most n steps, when applied to the minimization of strictly convex quadratic functions f. In this paper general conditions are given, which, together with the quadratic termination property, will ensure that the algorithm locally converges at least n-step quadratically to a local minimum anti x for sufficiently smooth nonquadratic functions f. It is also shown that these conditions apply to most algorithms with the quadratic termination property. (auth)

6284 (SU—326-P39-5) **System/360 emulator performance estimate.** Wallach, W.A. Jr. (Stanford Univ., Calif. (USA). Stanford Electronics Labs.). Nov 1975. Contract AT(04-3)-326. 13p. Dep. NTIS $3.50.

The performance and instruction timing of the System/360 Emulator for EMMY are described. The Stanford EMMY will emulate typical 360 instruction streams at about 97KIPS. A production (Model II Control Store) EMMY will achieve 143KIPS on the same instruction stream. A 360 Model 50 processes this stream at about 141KIPS. Minor modifications to the Stanford machine should enable it to achieve 120KIPS. (auth)

6285 (SU—326P39X3) **Functional description of the EMMY main memory system. Technical note No. 57.** Neuhauser, C. (Stanford Univ., Calif. (USA). Stanford Electronics Labs.). 25 Aug 1975. Contract AT(04-3)-326. 15p. Dep. NTIS $4.50.

The functional description of an emulation oriented main memory system for use on the EMMY bus system is given. The main memory system consists of a byte-addressable core memory system and a memory controller which performs elementary transformations on address and data under CPU control. (5 figures) (auth)

6286 (SU—326-PA30-39) **Hybrid difference methods for the initial boundary-value problem for hyperbolic equations.** Oliger, J. (Stanford Univ., Calif. (USA). Dept. of Computer Science). Feb 1975. Contract E(04-3)-326. 31p. (STAN-CS—75-481). Dep. NTIS $5.00.

The use of lower-order approximations in the neighborhood of boundaries coupled with higher-order interior approximations is examined for the mixed initial boundary-value problem for hyperbolic partial differential equations. Uniform error can be maintained using smaller grid intervals with the lower-order approximations near the boundaries. Stability results are presented for approximation to the initial boundary-value problem for the model equation u/sub t/ + cu/sub x/ = 0 which are fourth order in space and second order in time in the interior and second order in both space and time near the boundaries. These results are generalized to a class of methods of this type for hyperbolic systems. Computational results are presented and comparisons are made with other methods. (2 figures, 3 tables) (auth)

6287 (SU-SEL—75-037) **Stack working set: a characterization of spatial locality. Technical report No. 95.** Rau, B.R. (Stanford Univ., Calif. (USA). Stanford Electronics Labs.). Jul 1975. Contract AT(04-3)-326. 66p. (SU—326P-39-2). Dep. NTIS $5.50.

Multilevel memory hierarchies are attractive from the point of view of cost--performance. However, they present far greater problems than two-level hierarchies when it comes to analytic performance evaluation. This may be attributed to two factors: first, the page size (or the unit of information transfer between two levels) varies with the level in the hierarchy, and, secondly, the request streams that the lower (slower) levels see are the fault streams out of the immediately higher levels. Therefore, the request stream seen by each level is not necessarily the same as the one generated by the processor. Since the performance depends directly upon the properties of the request stream, this situation poses a problem. A model for program behavior, which explicitly characterizes the spatial locality of the program, is proposed and validated. It is shown that the spatial locality of a program is an invariant of the hierarchy when characterized in this manner. This invariance is used to solve the first problem stated -- that of the varying page sizes. An approximate technique is advanced for the characterization of the fault stream as a function of the request stream and the capacity of the level. A procedure is then outlined for evaluating the performance of a multilevel hierarchy analytically. (20 figures) (auth)

6288 (TID—26886) **Remote manipulators as a computer input device.** Capowski, J.J. (North Carolina Univ., Chapel Hill (USA)). 1971. 71p. Dep. NTIS $6.75.

Thesis.

As part of the Grope project, a study of computer-user communication utilizing the sense of kinesthesia, a pair of remote manipulator arms was set up in a master-slave mode. A digital computer system samples voltages present in the supporting electronic system of the manipulators. The user communicates to the computer through the manipulator system, using his motor skills controlled by his kinesthetic sense. The major problems are that the manipulator arms are not good computer I/O devices and that little is known about the kinesthetic sense from a human factors engineering standpoint. 34 figures, 1 table (auth)

6289 (UCCND-CSD—15) **Solving large systems of linear equations by factorization.** Arnurius, D.E. (Oak Ridge National Lab., Tenn. (USA)). Jun 1975. Contract W-7405-eng-26. 20p. Dep. NTIS $4.00.

6290 (UCCND-CSD-INF—72) **Comparative study of computer codes for integrating ordinary differential equations.** McGonigal, D.F. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). Dec 1975. Contract W-7405-eng-26. 112p. Dep. NTIS $6.50.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

An attempt is made to investigate some of the commonly available codes for solving ordinary first order differential equations. The types of codes tested were one-step methods, multistep methods, and extrapolation techniques. A common set of twenty-five test problems was established as a standard by which to test the codes. Each code was clocked to determine the quantity of computer time necessary to carry out the integrations and the results of each integration were compared to the analytical solution, were known, to check its accuracy. This examination revealed that, of the codes tested, the extrapolation codes proved to function in the fewest units of time and also produced the most accurate results at medium to high order error requirements. (auth)

6291 (UCID—16923) **Scientific computer animation.** Levine, S.; Scala, P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Oct 1975. Contract W-7405-Eng-48. 8p. Dep. NTIS $4.00.

Animation in general and computer animation in particular are discussed first. Then the occasions for using computer animation for scientific purposes are explained. (RWR)

6292 (UCID—16928) **SUBNET: a preprocessor for management of complex CPM networks.** McCall, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Sep 1975. Contract W-7405-eng-48. 13p. Dep. NTIS $4.00.

Procedures are described that facilitate the use of Critical Path Method (CPM) networks used in the management of large, complex sets of activities. Instructions for use of CPM software on the LLL Octopus system are given and examples of output are presented. (auth)

6293 (UCID—30040(Ed.7)) **TRIX AC: a set of general-purpose text editing commands.** Cecil, A.; Moll, H.; Rinde, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Oct 1975. Contract W-7405-Eng-48. 58p. Dep. NTIS $5.50.

This report describes all the commands in the AC dialect of the TRIX interactive interpreter. It is a convenient reference document for users already familiar with TRIX AC; however, new users should obtain a copy of the Utility Routine Summary Sheets, UR-003. (RWR)

6294 (UCID—30097(Rev.1)) **Structural-analysis movie postprocessor (SAMPP), user's manual.** Brown, B.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Oct 1975. Contract W-7405-Eng-48. 49p. Dep. NTIS $5.00.

SAMPP is a general routine for the display of three-dimensional, finite-element models and the results of both static and dynamic analyses. The postprocessor may be used to produce line drawings and continuous tone pictures, as well as animated-line-drawing movie sequences. The SAMPP uses a hidden-surface processor for the display of realistic perspective views. SAMPP is written in Fortran and is compiled, loaded, and run on the CDC 7600 computers of the Livermore time-sharing system. (3 figures) (auth)

6295 (UCID—30116) **GEARS: solution of ordinary differential equations having a sparse Jacobian matrix.** Spellmann, J.W.; Hindmarsh, A.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1975. Contract W-7405-Eng-48. 41p. Dep. NTIS $4.00.

GEARS is a package of subroutines for the numerical solution of systems of ordinary differential equations in which the Jacobian matrix has a sparse structure. GEARS was created by merging modified versions of GEAR and the Yale Sparse Matrix Package (YSMP). Although the primary emphasis in GEARS is on stiff systems, it may be used, in general, for problems with various degrees of stiffness. As with GEAR, the GEARS package used either the implicit Adams methods or backward differentiation formulas for solving the system of equations. Also, the user has several options with regard to the Jacobian of the system. (auth)

6296 (UCRL—76027) **Software security in networks.** Fletcher, J.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1975. 18p. Dep. NTIS $3.50.

Software security measures must control, limit, and in some cases prohibit the access of each resource to the other resources in the network. The restrictions should ensure that the computer system cannot be damaged or altered by any of its users, that the privacy of each user's resources is guaranteed, and that sensitive information is not released into an unprotected environment. Designers and programmers must specify the resources to be protected and select structures for conveniently representing access rights among those resources. They must use encryption where necessary, identify users and other resources external to the network, and consider security requirements at all points in the actual programming. 1 figure. (RWR)

6297 (UCRL—77443) **Microprocessor as a computer mainframe.** Conn, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1975. Contract W-7405-Eng-48. 7p. (CONF-751109—7). Dep. NTIS $4.50.

From 9. annual asilomar conference on circuits, systems and computers; Pacific Grove, California, USA (3 Nov 1975).

Some performance characteristics of microprocessors are briefly compared with other machines in order to establish their suitability as CPU's for a broad class of interactive problems. An appropriate architecture for a single-user machine is presented along with user-oriented software based on a general-purpose macro processor. (auth)

6298 Relative efficiency of finite difference and finite element methods. I. Hyperbolic problems and splines. Swartz, B.; Wendroff, B. (Los Alamos Scientific Lab., NM). *SIAM (Soc. Ind. Appl. Math.) J. Numer. Anal.;* **11**: No. 5, 979-993(Oct 1974).

The finite element method, using smooth splines as basis functions, applied to the model problem μ_t = cu/sub x/ with periodic data generates a differential-difference equation whose phase error is closely estimated and compared with the phase error of both explicit and high-order implicit centered differencing. The minimum work required to obtain a fixed error for several fully discrete schemes are computed and compared. (auth)

6299 Relation between the Galerkin and collocation methods using smooth splines. Swartz, B.; Wendroff, B. (Los Alamos Scientific Lab., NM). *SIAM (Soc. Ind. Appl. Math.) J. Numer. Anal.;* **11**: No. 5, 994-996(Oct 1974).

The periodic initial value problem for the semibounded differential equation $u_t = \Sigma$/sub k=0/sup p/ a/sub k/(delta/deltax)/sup k/u, where the a/sub k/ are constants, is considered. The spline-Galerkin scheme arising from splines of order μ, analyzed by Thomee, is observed to have precisely the same solution as the collocation scheme using a basis of cardinal splines of order 2μ. The fact that both methods have the convergence rate O(h/sup $2(\mu-[p/2])$/) then follows from known error bounds for spline interpolation and the stability of the Galerkin schemes. (auth)

6300 Extended L/sub p/-error bounds for spline and L-spline interpolation. Demko, S.; Varga, R.S. (Kent State Univ., OH). *J. Approx. Theory;* **12**: No. 3, 242-264(Nov 1974).

The error bounds for spline and L-spline interpolation which recently appeared [J. Approximation Theory, 6, 6 (1972)] are extended and improved. Hermite L-spline interpolation and an improved stability analysis for L-spline and Hermite L-spline interpolation are included. (RWR)

6301 (LA-tr—75-34) Representations of a group of diffeomorphisms associated with infinite configurations. Vershik, A.M.; Gel'fand, I.M.; Graev, M.I. (AN SSSR, Moscow. Inst. Prikladnoj Matematiki). 1975. Translation by H. Dahlby of IPM-Preprint-46. 113p. Dep. NTIS $5.50.

A set of unitary representations of the group of diffeomorphisms Diff X of a smooth noncompact manifold of X is constructed. Each of these representations is defined by the quasi-invariant measure μ in the configuration space (i.e., the local finite subsets) in X and by the representation rho of the symmetric group S/sub n/ (n = 1, 2, ...). The necessary and sufficient conditions of irreducibility of these representations are established. For the case of Poisson's measure μ the description of the corresponding ring of representations is given. (tr-auth)

6302 Extrapolated collocation for two-point boundary-value problems using cubic splines. Daniel, J.W. (Univ. of Texas, Austin); Swartz, B.K. *J. Inst. Math. Appl.;* **16**: 161-174(1975).

A form of collocation is presented, analyzed, and illustrated for the approximate solution of second-order two-point boundary-value problems for ordinary differential equations by use of smooth cubic splines. By collocating to a perturbed differential equation which is satisfied by an accurate spline interpolant of the true solution, the desired O(h/sup 4-j/ global accuracy is achieved for the jth derivative of the solution, together with enhanced accuracy for the derivatives at certain points; this should be compared with the O(h/sup 2-j/) bounds given by standard collocation at the joints. (auth)

6303 Omnibus test contours for departures from normality based on square root b_1 and b_2. Bowman, K.O. (Union Carbide Corp., Oak Ridge, TN); Shenton, L.R. *Biometrika;* **62**: No. 2, 243-250(1975).

The test statistic $X^2(\sqrt{b_1}) + X^2(b_2)$, where $X(\sqrt{b_1})$ and $X(b_2)$ are standardized normal equivalents to the sample skewness, $\sqrt{b_1}$, and kurtosis, b_2, statistics, is considered in normal sampling. By using the Johnson system, S/sub U/ and S/sub B/, as approximate normalizing distributions, contours in the $(\sqrt{b_1}, b_2)$ plane of the test statistic are set up for sample sizes ranging from 20 to 1000. 2 figures, 3 tables (auth)

6304 Convergence of Pade approximants to e^{-}/sup z/ on unbounded sets. Saff, E.B. (Univ. of South Florida, Tampa); Varga, R.S. *J. Approx. Theory;* **13**: No. 4, 470-488(Apr 1975).

The convergence in the uniform norm of particular Pade approximants to e/sup $^{-}$z/ on certain unbounded sets in the complex plane is considered. The convergence on the ray z = x + iy, x greater than or equal to O, y = 0, is studied: a necessary and sufficient condition for the uniform convergence of a sequence of Pade approximants to e/sup $^{-}$z/ on this set is given, as is a sufficient condition for the geometric convergence of a sequence of Pade approximants. The results are applied to the problem of constrained Chebyshev rational approximations to ereverse arrow/sup $^{-}$z/ on $[0,+\alpha]$. Convergence of particular Pade approximants on unbounded parabolic-like sets in the complex plane is also derived. (RWR)

6305 Numerical comparison of integral equations of the first and second kind for conformal mapping. Hayes, J.K.; Kahaner, D.K.; Kellner, R.G. (Los Alamos Scientific Lab., NM). *Math. Comput.;* **29**: No. 130, 512-521(Apr 1975).

Two methods for computing numerical conformal mappings are compared. The first, due to Symm, uses a Fredholm integral equation of the first kind, while the other, due to Lichtenstein, uses a Fredholm integral equation of the second kind. The two methods are tested on ellipses with different ratios of major to minor axes. The method based on the integral equation of the second kind is superior if the ratio is less than or equal to 2.5. The opposite is true if the ratio k is greater than or equal to 10. Similar results are obtained for other regions. 2 tables. (auth)

6306 Computer storage structure and utilization at a large scientific laboratory. Fletcher, J.G.; Fernbach, S.; Dubois, P.J.; Boer, G.L. (Univ. of California, Livermore). *Proc. IEEE (Inst. Electr. Electron. Eng.);* **63**: No. 8, 1104-1113(Aug 1975).

The Octopus computer network at the Lawrence Livermore Laboratory, University of California, Livermore, ties together one of the largest concentrations of computing capability in the world, serving about 1500 users. The network's information storage capacity is large in every range of access speed. There are computers with main memories of 30 Mbits and secondary storage of 10 Gbits, a shared tertiary store of 1 Tbit, and 30-40 thousand reels of magnetic tape. This storage supports correspondingly large numerical simulations and other application programs that require the continuous operation of four major computers. Efficient storage use necessitates proper design of algorithms and buffer structures on the part of both the users and the system implementors. The main problems that arise include maintenance of high data transfer rates, reliability in the presence of intermittent hardware failure, achieving balance between media with differing access speeds, flexibility of the indexing structure, and equitable allocation among users. The discussion covers these issues in some detail and includes a historical perspective and estimates of future trends. (auth)

INFORMATION HANDLING

6307 (CEA-N—1795) Automatic indexing, compiling, and classification. Andreewsky, A.; Fluhr, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Documentation). Jun 1975. 36p. (In French). INIS.

A review of the principles of automatic indexing is followed by a comparison and summing-up of work by the authors and by a Soviet staff from the Moscow INFORM-ELECTRO Institute. The mathematical and linguistic problems of the automatic building of thesaurus and automatic classification are examined. (FR)

6308 (CONF-750967—10) Information support of Energy Research and Development Administration's Environmental Program at Oak Ridge National Laboratory. Ulrikson, G.U. (Oak Ridge National Lab., Tenn. (USA)). 1975. Contract W-7405-eng-26. 48p. Dep. NTIS $5.50.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

The primary function of the Information Center Complex (ICC) at Oak Ridge National Laboratory, Oak Ridge, Tennessee, is to develop and correlate the information activities of the energy and related environmental research projects at ORNL and to systematize operations to achieve maximum response to the information needs of funding agencies and user community. The development of new data bases and information services as need arises is a major responsibility of ICC. Interactions among segments of ICC provide for a wide range of analysis and synthesis of knowledge, resulting in a synergistic effect. Present methods used to retrieve environmental information from the scientific literature are reviewed with respect to specific procedures employed by ICC, and the use of highly specialized data bases in relation to manual and computerized sources is discussed. Procedures employed for different types of queries and the search strategy utilized are summarized indicating the extent of coverage from the various data bases. The ICC matrix organization is described. This organiza-

tional structure is representative of the subject area disciplines which contribute to biomedical and environmental information and an intersecting structure which provides for the accomplishment of mission-oriented tasks overlapping general disciplines. The advantages of a matrix organization are discussed. (auth)

6309 (COO—2544-1) **Information processing systems analysis and design. Progress report, January 1, 1975—September 30, 1975.** Teichroew, D. (Michigan Univ., Ann Arbor (USA). Dept. of Industrial and Operations Engineering). 1975. Contract E(11-1)-2544. 19p. Dep. NTIS $4.50.

The ISDOS project at The University of Michigan has developed a structural computer-aided methodology of stating, recording, and analyzing requirements for Information Processing Systems. The methodology includes a formal language, Problem Statement Language, and a software system, Problem Statement Analyzer. The system is operational on a number of large computers, and is used by a number of public and private organizations. This report describes the major features of the language and the system. (3 figures) (auth)

6310 (LBL—4257) **Pricing of information: a model for selective dissemination of information services.** Zais, H.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-ENG-48. 265p. Dep. NTIS $10.00.

Thesis.

The pressures of limited budgets and of increased competition for use of funds are forcing information centers and libraries to reassess their financial underpinnings. A modified descriptive model from the field of industrial organization was applied to pricing of an information service, computer-assisted selective dissemination of information (SDI). The objective of the study was to determine if identifying the market structure of SDI centers, through use of the structure and conduct components of the model, could provide predictive indicators as to what SDI pricing behavior would be like. Twenty-three centers that offer current awareness services from machine-readable bibliographic data bases were considered firms in an industry. A market structure was identified for the "industry" and, on the basis of this structure, pricing conduct patterns were suggested. The centers appeared to function as a moderate-to-highly concentrated oligopolistic industry, operating in regional markets and/or with elements of local monopoly power. Information on various user groups revealed market segments with differing potentials for growth and with different price elasticities of demand for SDI service. On the basis of this structure, oligopolistic pricing conduct patterns were suggested and compared with SDI pricing policies and practices observed in the data of the survey. Evidence is not conclusive that the model applies. A mixed pattern of pricing conduct was presented by the survey data. Several features of SDI pricing behavior present in the survey data were anticipated by the model, but several were not. The oligopolistic structure and conduct identified by the model did describe, however, the behavior of that segment of the SDI industry whose centers compete to serve the same pool of potential users from the chemistry-related data bases. (20 figures, 31 tables) (auth)

6311 (ORNL-TM—5182) **Regional and urban studies socioeconomic data bases at Oak Ridge National Laboratory.** Loebl, A.S.; Burch, D.F.; Malthouse, N.S. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 57p. Dep. NTIS $5.45.

A machine readable data base maintained under the ORCHIS system has been created which contains documentation for all socioeconomic data bases managed by the RUSTIC program. This document describes the hierarchical relationships of the records within the data base and includes a structured, formatted catalog of the RUSTIC program holdings, produced automatically by ORCHIS. (auth)

6312 (SAND—75-0242) **Patricia III: systems description.** Thompson, R.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Apr 1975. Contract AT(29-1)-789. 19p. Dep. NTIS $4.00.

6313 (UCID—16916) **Use of the LLL fire data base.** Strout, R.E. II. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Oct 1975. Contract W-7405-Eng-48. 23p. Dep. NTIS $4.00.

A data base containing references to literature concerning different aspects of fire technology was created. The data base allows a researcher to use the MASTER CONTROL program to retrieve references concerning only those parts of fire technology which interest him. References can also be added to the data base. References were collected from Engineering Index/The Journal of Fire and Flammability. Instructions for searching and adding records are expounded. 1 figure. (RWR)

6314 (UNI-SA—19) **Programming records disposition into computer systems.** Schauss, B. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 23 Oct 1975. 7p. (CONF-751052—1). Dep. NTIS $4.50.

From ERDA records management conference; Idaho Falls, Idaho, USA (23 Oct 1975).

The need for disposing of obsolete records (and erasure and re-use of magnetic tapes) in computer systems at definite times and methods for achieving this procedure are discussed. (RWR)

6315 **Relative effectiveness of titles, abstracts, and subject headings for machine retrieval from the COMPENDEX services.** Byrne, J.R. (Univ. of California, Livermore). *J. Am. Soc. Inf. Sci.*; 26: No. 4, 223-229(1975).

The relative merits of searching on titles, subject headings, abstracts, free-language terms, and combinations of these elements were investigated. The COMPENDEX data base was used for this study since it contained all of the data elements of interest. In general, the results obtained from the experiments indicate that, as expected, titles alone are not satisfactory for efficient retrieval. The combination of titles and abstracts came the closest to 100 percent retrieval, with searching of abstracts alone doing almost as well. Subject headings and free-language terms, although necessary for 100 percent retrieval in almost all cases, were found to be relatively unimportant. 3 tables. (auth)

CORPORATE INDEX

In the corporate index, technical report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

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A

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Solar heating proof-of-concept experiment for a public school building. Report for January—May 1974, 1:4808 (PB—240610)

Aerojet Nuclear Co., Idaho Falls, Idaho (USA)
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Removal of the Materials Test Reactor overhead working reservoir, 1:5391 (ANCR—1257)
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Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.
Basic interrupt and command structures and applications, 1:6258 (CONF-750482—1)
Decontamination and decommissioning of the EBR-I complex. Topical report No. 3. NAK disposal pilot plant test, 1:4982 (ANCR—1170)
Experiment DTA report for semiscale transparent vessel countercurrent flow tests, 1:4994 (ANCR—1163)
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Heat treatment versus properties studies associated with the Inconel 718 PBF acoustic filters, 1:5157 (CONF-750574—1)

Aerospace Corp., El Segundo, Calif. (USA)
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Solar thermal conversion mission analysis. Volume I. Summary report: southwestern United states, 1:4686 (PB—242898)
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Air Products and Chemicals, Inc., Allentown, Pa. (USA)
Chemical characterization, handling, and refining of SRC to liquid fuels. Quarterly progress report, June—September 1975 , 1:4527 (FE—2003-3)

Alaska Univ., College (USA). Geophysical Inst.
Summer global radiation and albedo: data for three stations in the Arctic basin, Ice Island T-3, Barrow, Prudhoe Bay, 1971—1973, 1:4670 (AD/A—003932)

Alliance for Engineering in Medicine and Biology, Chevy Chase, Md. (USA)
Geology, physical properties, and surface effects at Discus thrower site, Yucca Flat, Nevada Test Site, 1:5654 (TID—26912)

Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs - Operations Office
Idaho Chemical Processing Plant training program, 1:4576 (CONF-750515—4)

Allied-Gulf Nuclear Services, Barnwell, S.C. (USA)
Barnwell Nuclear Fuel Plant. License application, FSAR, amendment 6, 1:4577 (DOCKET-50332—52)

American Cyanamid Co., Stamford, Conn.
Exploratory development of transparent conductor materials. Final report, 1:4690 (AD/A—008783)
Research on cadmium stannate selective optical films for solar energy applications. Semiannual progress report, 1 January—30 June 1974, 1:4843 (PB—236208)

Research on cadmium stannate selective optical films for solar energy applications. Quarterly report No. 3, 1 July—30 September 1974, 1:4714 (PB—239372)

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Chemical Engineering Division. Liquid metals chemistry and tritium control technology annual report, July 1974—June 1975, 1:5393 (ANL—75-50)

Chemical Engineering Division thermochemical studies. Annual report, July 1974—June 1975, 1:5392 (ANL—75-47)

Chemical Engineering Division waste management programs. Quarterly report, January—March 1975, 1:4582 (ANL—73-43)

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Retention of plutonium in mouse tissues as affected by antiviral compounds and their analogs, 1:5820 (CONF-751205—7)

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Single crystal neutron diffraction studies of mixed-valence $K_2Pt(CN)_4Br$/sub 0.3//sup ./3.OH_2O, $K_2Pt(CN)_4Cl$/sub 0.3//sup ./3.OH_2O, and K/sub 1.75/$Pt(CN)_4$/sup ./1.5H_20: new results and a summary, 1:5338 (CONF-751212—2)

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Title (supplementary information), citation number (report number)

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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CONF-750950-		
3	1:5491	*See* BNL-20605
4	1:5496	*See* BNL-20565
CONF-750955-		
1	1:5947	*See* BNL-20433
CONF-750957-		
3	1:5719	*See* UCRL-77533
CONF-750961-		
1	1:4907	*See* BNWL-SA-5557
CONF-750966-		
1	1:5000	Dep. NTIS, $4.75
2	1:5001	Dep. NTIS, $4.75
CONF-750967-		
4	1:5644	*See* DPSPU-75-30-8
7	1:4895	*See* K-GD-1330
10	1:6308	Dep. NTIS, $5.50
11	1:5592	Dep. NTIS, $4.00
12	1:5788	*See* SAND-75-5640
13	1:5613	*See* UCRL-76936
15	1:5640	*See* BNWL-SA-5494(Pt.1)
16	1:5641	*See* BNWL-SA-5494(Pt.2)
19	1:5605	*See* BNWL-SA-5482
20	1:5676	*See* BNWL-SA-5484
CONF-750968-		
1	1:4612	Dep. NTIS, $4.00
2	1:5137	Dep. NTIS, $5.00
CONF-750972-		
1	1:4939	*See* HEDL-SA-986
CONF-750974-		
1	1:6274	*See* LBL-4233
CONF-750975-		
3	1:5969	Dep. NTIS, $4.50
10	1:5860	*See* LBL-4258
CONF-750976-		
1	1:5905	*See* LBL-4311
CONF-750984-		
1	1:4984	Dep. NTIS, $4.75
CONF-750985-		
1	1:5639	*See* BNWL-SA-5451
3	1:5828	*See* BNWL-SA-5531
CONF-750987-		
1	1:6273	*See* LA-UR-75-2013
CONF-750991-		
1	1:5323	*See* LBL-3975
CONF-750992-		
2	1:5087	*See* LBL-4408
CONF-750993-		
1	1:5342	*See* LBL-3929
2	1:5523	*See* LBL-3930
CONF-750995-		
1	1:5713	*See* COO-3110-20
CONF-751006-		
8	1:5236	*See* UCRL-77345
10	1:5233	*See* SAND-75-5386
12	1:5224	Dep. NTIS, $4.50
13	1:5225	Dep. NTIS, $4.50
14	1:5226	Dep. NTIS, $4.50
16	1:5227	Dep. NTIS, $4.50
17	1:5231	*See* COO-3158-45
18	1:5228	Dep. NTIS, $4.50
CONF-751007-		
5	1:4933	*See* GA-A-13653
CONF-751009-		
2	1:5306	*See* DP-MS-75-37
3	1:5307	*See* DP-MS-75-38
CONF-751011-		
2	1:6272	*See* LA-UR-75-1990
3	1:6260	Dep. NTIS, $5.00
4	1:6265	*See* DP-MS-75-108
CONF-751012-		
6	1:5138	Dep. NTIS, $4.00
7	1:5139	Dep. NTIS, $4.00
9	1:5140	Dep. NTIS, $4.50
11	1:5145	*See* Y-DA-6352
12	1:5147	*See* Y-OA-1550
CONF-751013-		
9	1:5002	Dep. NTIS, $4.00
CONF-751016-		
4	1:5464	*See* DP-MS-75-86
CONF-751017-		
13	1:4610	*See* SAND-75-5351
14	1:4607	*See* BNWL-SA-5559
CONF-751025-		
1	1:6058	*See* LBL-4212
CONF-751026-		
6	1:5229	Dep. NTIS, $4.00
8	1:5230	Dep. NTIS, $4.00
13	1:5181	*See* UCRL-77290
23	1:6240	*See* UCRL-77153
25	1:6227	*See* BNWL-SA-5422
31	1:5683	*See* BNWL-SA-5416
32	1:6245	*See* UCRL-77357(Rev.1)
33	1:6177	*See* BNL-20581
CONF-751027-		
2	1:5721	*See* BNL-20532
5	1:5710	*See* LA-UR-75-1986
CONF-751029-		
1	1:5437	Dep. NTIS, $4.00
CONF-751030-		
1	1:4914	*See* GA-A-13506
CONF-751031-		
1	1:5770	Dep. NTIS, $5.25
CONF-751033-		
1	1:5409	*See* SAND-75-5362
CONF-751034-		
1	1:5812	Dep. NTIS, $4.25
CONF-751035-		
1	1:4503	Dep. NTIS, $4.00
CONF-751038-		
1	1:5253	*See* DP-MS-75-62
3	1:5259	*See* BNWL-SA-5513
CONF-751040-		
1	1:5402	*See* HEDL-SA-754
2	1:5725	Dep. NTIS, $4.00
CONF-751043-		
5	1:5806	*See* BNWL-SA-5550
CONF-751047-		
1	1:6248	Dep. NTIS, $4.50
2	1:6249	Dep. NTIS, $4.50
CONF-751048-		
3	1:5494	Dep. NTIS, $4.50
CONF-751049-		
1	1:5131	*See* SAND-75-5995
CONF-751050-		
1	1:5590	*See* BNWL-SA-5551
CONF-751051-		
1	1:5232	*See* HEDL-SA-1036
CONF-751052-		
1	1:6314	*See* UNI-SA-19
CONF-751053-		
1	1:5473	*See* SAND-75-6063
CONF-751054-		
1	1:5321	*See* KAPL-P-4041

Report No.	Abstract No.	Availibility
CONF-751055-		
2	1:5040	*See* BNL-20566
CONF-751057-		
1	1:5626	Dep. NTIS, $4.50
CONF-751064-		
1	1:5624	Dep. NTIS, $4.50
CONF-751067-		
1	1:5498	*See* BNL-20609
CONF-751068-		
1	1:4884	*See* LBL-4420
CONF-751072-		
1	1:5526	*See* SAND-75-5462
CONF-751074-		
1	1:4536	Dep. NTIS, $5.50
CONF-751101-		
20	1:5983	Dep. NTIS, $4.50
21	1:4616	*See* DP-MS-75-9
23	1:5438	Dep. NTIS, $4.00
24	1:5439	*See* SAND-75-5658
27	1:5505	*See* EGG-1183-2319
37	1:4594	*See* SAND-75-5601
41	1:5232	*See* HEDL-SA-1036
42	1:4968	*See* DP-MS-75-53
44	1:4976	*See* DP-MS-75-60
45	1:4923	Dep. NTIS, $4.50
48	1:4924	Dep. NTIS, $4.50
49	1:5260	*See* DP-MS-75-67
51	1:4925	Dep. NTIS, $5.00
52	1:4565	*See* K-L-6353
57	1:6229	Dep. NTIS, $4.50
58	1:6234	*See* GA-A-13665
60	1:6167	*See* UCRL-76985
63	1:4551	Dep. NTIS, $5.00
CONF-751102-		
1	1:5440	*See* LA-UR-75-1832
3	1:5442	*See* SAND-75-5629
CONF-751104-		
1	1:6045	*See* LA-UR-75-1747
2	1:6049	Dep. NTIS, $6.00
CONF-751105-		
3	1:5647	*See* UCRL-77318
4	1:5643	Dep. NTIS, $4.00
6	1:5642	*See* BNWL-SA-5505
8	1:4622	*See* LA-UR-75-2037
14	1:5814	*See* BNWL-SA-5388
16	1:5807	*See* BNWL-SA-5588
17	1:5808	Dep. NTIS, $4.50
18	1:4600	*See* ARH-SA-232
CONF-751106-		
2	1:5162	*See* HEDL-SA-925
10	1:5269	*See* SAND-75-5390
13	1:5459	Dep. NTIS, $5.50
14	1:5410	*See* SAND-75-5643
15	1:4540	Dep. NTIS, $4.50
16	1:4541	Dep. NTIS, $4.50
CONF-751107-		
2	1:4588	*See* DP-MS-75-17
3	1:4599	*See* ARH-SA-221
5	1:4589	*See* DP-MS-75-19
9	1:5086	Dep. NTIS, $4.50
14	1:5041	*See* BNL-20567
CONF-751108-		
1	1:6135	*See* UCRL-77024
2	1:6134	*See* SAND-75-5747
3	1:5460	*See* SAND-75-5478
4	1:5411	*See* SAND-75-5744
8	1:5488	*See* SAND-75-5746
13	1:5475	*See* UCRL-77449
16	1:6208	*See* UCRL-77456
CONF-751109-		
7	1:6297	*See* UCRL-77443
CONF-751110-		
1	1:6261	Dep. NTIS, $4.00
CONF-751113-		
5	1:5429	Dep. NTIS, $4.50
6	1:6262	Dep. NTIS, $5.00
CONF-751114-		
3	1:4617	*See* DP-MS-75-103
CONF-751115-		
1	1:5482	Dep. NTIS, $4.50
CONF-751116-		
1	1:5511	
2	1:5499	*See* BNL-20366
4	1:5495	Dep. NTIS, $4.50
5	1:6129	*See* UCRL-77478
6	1:5502	Dep. NTIS, $4.50
7	1:5503	Dep. NTIS, $5.00
9	1:4985	Dep. NTIS, $4.50
13	1:5658	*See* BNL-20665
14	1:6254	*See* BNL-20666
17	1:6255	*See* BNL-20667
18	1:6253	*See* BNL-20645
CONF-751119-		
1	1:5623	Dep. NTIS, $4.50
2	1:4915	*See* GA-A-13709
CONF-751121-		
1	1:5276	Dep. NTIS, $4.50
CONF-751123-		
1	1:5211	*See* KAPL-P-4042
CONF-751125-		
1	1:6170	*See* UCRL-77260
2	1:6168	*See* UCRL-77233
3	1:6172	*See* UCRL-77269
4	1:6222	*See* UCRL-77499
5	1:6169	*See* UCRL-77243
6	1:6146	*See* UCRL-77230
7	1:6204	Dep. NTIS, $4.50
8	1:6178	Dep. NTIS, $4.50
9	1:6219	*See* UCRL-77242
10	1:6221	*See* UCRL-77249
11	1:6195	*See* UCRL-77244
12	1:6220	*See* UCRL-77248
14	1:6230	Dep. NTIS, $4.50
15	1:6216	*See* UCRL-76341
16	1:6130	*See* UCRL-77504
17	1:6207	*See* UCRL-77239
18	1:6193	*See* UCRL-77235
19	1:6171	*See* UCRL-77264
20	1:6201	*See* UCRL-77215
21	1:6128	*See* UCRL-77247
22	1:6243	*See* UCRL-77236
23	1:6206	*See* UCRL-77105
24	1:6244	*See* UCRL-77238
25	1:6194	*See* UCRL-77241
26	1:6242	*See* UCRL-77234
28	1:6192	*See* UCRL-77227
29	1:6241	*See* UCRL-77226
35	1:6179	Dep. NTIS, $4.50
36	1:6180	Dep. NTIS, $4.50
37	1:5430	Dep. NTIS, $4.50
38	1:6181	Dep. NTIS, $4.50
39	1:6182	Dep. NTIS, $4.50
40	1:6231	Dep. NTIS, $4.50
41	1:6175	Dep. NTIS, $4.50
42	1:6183	Dep. NTIS, $4.50
43	1:6232	Dep. NTIS, $4.50
45	1:6184	Dep. NTIS, $4.00
46	1:6209	Dep. NTIS, $4.50
47	1:6163	*See* LA-UR-75-2153
51	1:6197	*See* LA-UR-75-2129
52	1:6198	*See* LA-UR-75-2154
53	1:6200	*See* LA-UR-75-2183
54	1:6196	*See* LA-UR-75-2128
55	1:6199	*See* LA-UR-75-2158
58	1:6185	Dep. NTIS, $4.50
60	1:6158	Dep. NTIS, $4.50
61	1:6159	Dep. NTIS, $4.50
62	1:6186	Dep. NTIS, $4.50
63	1:6160	Dep. NTIS, $4.50
64	1:6161	Dep. NTIS, $4.50
65	1:6111	Dep. NTIS, $4.50
66	1:6187	Dep. NTIS, $4.50
68	1:6233	Dep. NTIS, $4.50
CONF-751126-		
1	1:5799	Dep. NTIS, $4.50
2	1:5811	*See* LA-UR-75-1905
4	1:5819	Dep. NTIS, $4.50
6	1:5810	Dep. NTIS, $4.50
7	1:5809	*See* BNL-20599
CONF-751130-		
1	1:6115	*See* UCRL-77079
2	1:6214	*See* SAND-75-5666
3	1:6217	*See* UCRL-77094(Rev.1)
CONF-751131-		
1	1:6218	*See* UCRL-77127
CONF-751133-		
1	1:5293	*See* UCRL-77547
2	1:5025	*See* UCRL-77543
3	1:5028	*See* UCRL-77569
4	1:5026	*See* UCRL-77567

Report No.	Abstract No.	Availibility
5	1:5027	*See* UCRL-77568
6	1:5024	*See* UCRL-77486
CONF-751139-		
1	1:5476	*See* UCRL-77454
CONF-751146-		
1	1:5506	*See* EGG-1183-2329
CONF-751150-		
1	1:5312	Dep. NTIS, $4.50
2	1:5313	Dep. NTIS, $4.50
CONF-751151-		
1	1:5628	*See* LA-UR-75-2136
CONF-751154-		
1	1:4864	*See* SAND-75-6160
CONF-751159-		
1	1:5684	*See* DP-MS-75-102
CONF-751201-		
1	1:5728	*See* FMI-1000-605
CONF-751202-		
1	1:5833	*See* LA-UR-75-735
CONF-751204-		
2	1:4581	*See* UCRL-77395
CONF-751205-		
	1:5818	*See* BNWL-SA-5464
4	1:5816	*See* LA-UR-75-1887
6	1:5817	*See* BNWL-SA-5456
7	1:5820	Dep. NTIS, $4.50
CONF-751206-		
2	1:4719	*See* SAND-75-5730
3	1:5474	*See* SAND-75-7081
CONF-751208-		
1	1:6281	*See* SAND-75-5884
CONF-751209-		
3	1:6084	*See* SAND-75-5752
4	1:5252	Dep. NTIS, $4.50
7	1:5178	Dep. NTIS, $4.50
11	1:5988	*See* IS-M-54
15	1:5284	*See* BNL-20601
CONF-751211-		
2	1:5722	Dep. NTIS, $5.00
CONF-751212-		
2	1:5338	Dep. NTIS, $5.00
CONF-751213-		
1	1:4891	Dep. NTIS, $4.50
2	1:4892	Dep. NTIS, $5.50
3	1:4533	Dep. NTIS, $4.50
CONF-751214-		
1	1:4547	Dep. NTIS, $5.00
CONF-751215-		
1	1:4504	Dep. NTIS, $4.50
CONF-751216-		
1	1:5667	Dep. NTIS, $4.50
CONF-751219-		
1	1:5712	Dep. NTIS, $5.00
CONF-760101-		
1	1:5968	*See* LA-UR-75-2050
CONF-760102-		
1	1:5412	*See* SAND-75-5993
CONF-760103-		
1	1:6271	*See* LA-UR-75-1653
CONF-760201-		
1	1:5023	*See* UCRL-76891
COO-		
1314-36	1:5688	Dep. NTIS, $4.50
1422-8	1:5726	Dep. NTIS, $4.50
1428-424	1:5961	Dep. NTIS, $4.50
1428-426	1:5948	Dep. NTIS, $4.50
1428-429	1:5965	Dep. NTIS, $4.50
1569-132	1:6091	Dep. NTIS, $5.00
1672-61	1:6041	Dep. NTIS, $4.50
1676-37	1:5158	Dep. NTIS, $4.50
1805-2	1:5483	Dep. NTIS, $4.50
2152-18	1:5003	Dep. NTIS, $5.45
2164-14	1:5689	Dep. NTIS, $4.50
2171-54	1:5943	Dep. NTIS, $4.50
2172-5	1:5159	Dep. NTIS, $5.00
2172-11	1:5160	Dep. NTIS, $5.00
2180-5	1:6121	Dep. NTIS, $7.00
2180-6	1:6122	Dep. NTIS, $5.00
2190-16	1:5388	Dep. NTIS, $4.50
2195-21	1:5584	Dep. NTIS, $7.75
2203-4	1:5896	Dep. NTIS, $4.50
2245-16TR	1:4926	Dep. NTIS, $8.75
2245-17TR	1:4927	Dep. NTIS, $4.50
2245-18TR	1:4928	Dep. NTIS, $6.50
2249-5	1:5585	Dep. NTIS, $5.00

Report No.	Abstract No.	Availibility
2250-2	1:4929	Dep. NTIS, $7.00
2262-8	1:4967	Dep. NTIS, $8.50
2263-2	1:5075	Dep. NTIS, $10.00
2271-53B	1:5953	Dep. NTIS, $4.50
2271-60	1:6098	Dep. NTIS, $4.50
2271-61	1:5932	Dep. NTIS, $5.00
2271-62	1:5970	Dep. NTIS, $4.50
2307-9	1:5653	Dep. NTIS, $4.50
2314-7	1:6094	Dep. NTIS, $4.50
2383-0024	1:6263	Dep. NTIS, $4.50
2383-0028	1:6264	Dep. NTIS, $22.25
2407-3	1:5261	Dep. NTIS, $4.50
2500-1	1:4893	Dep. NTIS, $4.50
2522-1	1:5431	Dep. NTIS, $7.00
2534-1	1:5627	Dep. NTIS, $5.00
2544-1	1:6309	Dep. NTIS, $4.50
2597-1	1:4838	Dep. NTIS, $5.50
2689-1	1:4603	Dep. NTIS, $5.00
2691-1	1:4789	Dep. NTIS, $4.00
3011-5	1:5652	Dep. NTIS, $6.50
3065-124	1:5914	Dep. NTIS, $5.00
3065-125	1:5933	Dep. NTIS, $4.50
3070-130	1:6140	Dep. NTIS, $4.50
3084-38	1:5161	Dep. NTIS, $4.50
3110-20	1:5713	Dep. NTIS, $4.50
3130-TB-211	1:5915	Dep. NTIS, $4.75
3158-45	1:5231	Dep. NTIS, $4.50
3173-14	1:5727	Dep. NTIS, $4.50
3232-7	1:5787	Dep. NTIS, $5.00
3244-48	1:6008	Dep. NTIS, $4.50
3267-08	1:5800	Dep. NTIS, $4.50
3267-09	1:5801	Dep. NTIS, $4.50
3285—22	1:5954	Dep. NTIS, $4.25
3342-4	1:5126	Dep. NTIS, $4.50
3435-21	1:5379	Dep. NTIS, $6.50
3435-24	1:5380	Dep. NTIS, $5.50
3462-12	1:4561	Dep. NTIS, $5.00
3490-837	1:5690	Dep. NTIS, $8.50
3521-4	1:5781	Dep. NTIS, $4.50
3521-5	1:5691	Dep. NTIS, $4.50
3539-6	1:5901	Dep. NTIS, $4.50
3581-3	1:4566	Dep. NTIS, $5.00
COO/SH-C-		
903/75/1	1:4799	Dep. NTIS, $5.00
CRN-CNPA-		
75-8	1:4693	INIS
DOCKET-50332-		
52	1:4577	Dep. NTIS, $26.00
DP-		
159	1:5333	Dep. NTIS, $5.00
638	1:4578	Dep. NTIS, $4.50
1371	1:4585	Dep. NTIS, $4.00
1374	1:5593	Dep. NTIS, $7.60
1379	1:5520	Dep. NTIS, $4.00
1383	1:4586	Dep. NTIS, $4.00
1384	1:5320	Dep. NTIS, $4.00
1397	1:4587	Dep. NTIS, $4;00
DP-MS-		
75-9	1:4616	Dep. NTIS, $4.25
75-17	1:4588	Dep. NTIS, $5.00
75-19	1:4589	Dep. NTIS, $4.00
75-37	1:5306	Dep. NTIS, $4.50
75-38	1:5307	Dep. NTIS, $4.50
75-53	1:4968	Dep. NTIS, $4.50
75-60	1:4976	Dep. NTIS, $4.25
75-62	1:5253	Dep. NTIS, $5.00
75-67	1:5260	Dep. NTIS, $4.50
75-86	1:5464	Dep. NTIS, $4.50
75-102	1:5684	Dep. NTIS, $4.50
75-103	1:4617	Dep. NTIS, $4.50
75-108	1:6265	Dep. NTIS, $4.50
DPSPU-		
75-30-8	1:5644	Dep. NTIS, $4.00
DPST-		
75-452	1:4590	Dep. NTIS, $4.50
E-		
7915	1:4841	*See* N-30121
8109	1:4696	*See* N-75-15585
8116	1:4840	*See* N-75-12329
8247	1:4671	*See* N-75-16080
EGG-		
1183-1635	1:5504	Dep. NTIS, $4.00
1183-2319	1:5505	Dep. NTIS, $4.00
1183-2329	1:5506	Dep. NTIS, $4.50

Report No.	Abstract No.	Availibility
ENDF-		
223	1:6017	*See* LA-6116-MS
EPA-		
650/4-75/017	1:4675	*See* PB-243635
EPRI-SR-		
11	1:5594	NTIS, $5.45
ERDA-		
53	1:5055	Dep. NTIS, $4.50
73	1:4966	Dep. NTIS, $7.60
74	1:4894	Dep. NTIS, $10.60
75	1:4801	Dep. NTIS, $12.75
82(Vol.1)	1:5047	Dep. NTIS, $45.25
82(Vol.2)	1:5048	Dep. NTIS, $47.00
82(Vol.3)	1:5049	Dep. NTIS, $40.00
82(Vol.4)	1:5050	Dep. NTIS, $38.00
82(Vol.5)	1:5051	Dep. NTIS, $21.75
82(Vol.6)	1:5052	Dep. NTIS, $22.75
83	1:5902	Dep. NTIS, $5.00
84	1:4885	Dep. NTIS, $5.45
89	1:6162	Dep. NTIS, $5.45
1540	1:5606	Office of the Assistant Administrator, Washington, D.C.
ERDA/JPL-		
954344-75/1	1:4694	Dep. NTIS, $4.00
ERDA-SNS-		
3063-7	1:4621	*See* FSEC-NSG-217-75/50
ERDA-tr-		
67	1:5649	Dep. NTIS, $4.25
68	1:6118	Dep. NTIS, $4.00
71	1:5466	Dep. NTIS, $4.00
72	1:5467	Dep. NTIS, $4.00
95	1:4881	Dep. NTIS, $4.00
FE-		
381-T9-P1	1:4505	Dep. NTIS, $11.75
381-T9-P2	1:4508	Dep. NTIS, $12.75
381-T9-P3	1:4511	Dep. NTIS, $12.00
381-T9-P4	1:4515	Dep. NTIS, $14.75
496-T5	1:4496	Dep. NTIS, $5.45
496-T8	1:4497	Dep. NTIS, $5.45
1207-I(Vol.1)	1:4518	Dep. NTIS, $13.60
1207-I(Vol.2)	1:4519	Dep. NTIS, $13.60
1207-I(Vol.3)	1:4520	Dep. NTIS, $13.60
1224-41	1:4525	Dep. NTIS, $5.00
1225-1	1:4498	Dep. NTIS, $4.00
1552-1(Vol.1)	1:4542	Dep. NTIS, $6.00
1552-1(Vol.2)	1:4543	Dep. NTIS, $7.00
1752-9	1:4486	Dep. NTIS, $4.00
1760-1	1:5068	Dep. NTIS, $5.50
1760-10	1:5069	Dep. NTIS, $5.50
1767-3	1:4521	Dep. NTIS, $4.50
1772-6	1:4487	Dep. NTIS, $4.50
1774-T1	1:4488	Dep. NTIS, $7.60
1775-2	1:4493	Dep. NTIS, $3.50
1814-1	1:4522	Dep. NTIS, $4.00
2003-3	1:4527	Dep. NTIS, $4.00
2007-4	1:4526	Dep. NTIS, $4.00
FERMILAB-Conf-		
75/63	1:5934	Dep. NTIS, $4.00
75/71-THY	1:5935	Dep. NTIS, $5.00
75/72-THY	1:5936	Dep. NTIS, $5.00
75/79-THY	1:5962	Dep. NTIS, $4.50
FMI-		
1000-605	1:5728	Dep. NTIS, $4.50
FRNC-TH-		
540	1:6106	INIS
FSEC-NSG-		
217-75/50	1:4621	Dep. NTIS, $6.75
FSU-HEP-		
75-1-03	1:5926	Dep. NTIS, $8.50
75-6-5	1:5512	Dep. NTIS, $5.00
GA-A-		
13148	1:4930	Dep. NTIS, $5.45
13301	1:4913	Dep. NTIS, $7.60
13327	1:4931	Dep. NTIS, $4.00
13458	1:4932	Dep. NTIS, $7.60
13506	1:4914	Dep. NTIS, $4.00
13651	1:4653	Dep. NTIS, $4.50
13653	1:4933	Dep. NTIS, $4.50
13665	1:6234	Dep. NTIS, $4.50
13709	1:4915	Dep. NTIS, $5.00
GEAP-		
13771-15	1:4934	AT
14029-3	1:5209	AT
14029-4	1:5210	AT
14039-2	1:4935	AT
14053	1:5004	AT
14054	1:4936	AT
14055	1:5005	AT
14057	1:4986	AT
14064	1:4937	AT
GERHTR-		
117	1:5521	Dep. NTIS, $5.00
134	1:5278	Dep. NTIS, $5.50
GESR-		
2113	1:4987	Dep. NTIS, $7.75
HASL-		
297	1:5607	Dep. NTIS, $7.60
297(App.)	1:5608	Dep. NTIS, $10.60
HEDL-SA-		
754	1:5402	Dep. NTIS, $4.50
771	1:5006	Dep. NTIS, $18.25
925	1:5162	Dep. NTIS, $4.50
960(Rev.)	1:4938	Dep. NTIS, $4.25
986	1:4939	Dep. NTIS, $5.00
1036	1:5232	Dep. NTIS, $4.50
HEDL-TC-		
372	1:5007	AT
HEDL-TME-		
74-42	1:4940	AT
75-38	1:5685	AT
75-40	1:5008	AT
75-80	1:5163	Dep. NTIS, $4.25
75-89	1:4941	AT
75-91	1:4567	AT
75-92	1:4988	AT
HIG-		
75-6	1:4867	Dep. NTIS, $4.50
HW-		
47152	1:5677	Dep. NTIS, $4.50
IFA-SR-		
11-1974	1:6083	INIS
IS-M-		
54	1:5988	Dep. NTIS, $4.50
IS-T-		
697	1:5179	Dep. NTIS, $7.75
ISO-		
419	1:4579	Dep. NTIS, $7.00
JAERI-M-		
5980	1:6266	INIS
JINR-		
P9-9120	1:5485	Dep. NTIS (US Sales Only), $4.00
P11-9107	1:5486	Dep. NTIS (US Sales Only), $4.50
P13-9146	1:5853	Dep. NTIS (US Sales Only), $4.50
R-12-7440	1:5339	INIS
JPL-SP-		
43-12	1:4717	*See* PB-242529
JUL-		
957-PC	1:5340	Dep. NTIS (US Sales Only), $4.50
1019-BO	1:5692	Dep. NTIS (US Sales Only), $9.00
1036-PC	1:5751	Dep. NTIS (US Sales Only), $5.00
1055-TP	1:5072	Dep. NTIS (US Sales Only), $8.75
1204	1:6073	Dep. NTIS (US Sales Only), $11.75
1213	1:5054	Dep. NTIS (US Sales Only), $7.75
1220	1:5609	Dep. NTIS (US Sales Only), $9.00
1236(Pt.1)	1:5084	Dep. NTIS (US Sales Only), $5.00
K-GD-		
1330	1:4895	Dep. NTIS, $4.50
K-L-		
6353	1:4565	Dep. NTIS, $5.00
KAPL-P-		
4017	1:4802	Dep. NTIS, $4.75
4041	1:5321	Dep. NTIS, $4.50
4042	1:5211	Dep. NTIS, $4.50
KFK-		
2153	1:5610	Dep. NTIS (US Sales Only), $7.75

Report No.	Abstract No.	Availibility
KFK-EXT-		
6/75-3	1:5714	Dep. NTIS (US Sales Only), $5.00
20/75-1	1:5611	
KFK-PDV-		
50	1:6267	Dep. NTIS (US Sales Only), $6.50
KFKI-		
75-50	1:5242	Dep. NTIS (US Sales Only), $4.50
75-60	1:6268	Dep. NTIS (US Sales Only), $5.00
LA-		
5898-MS	1:6212	Dep. NTIS, $4.00
5900-MS	1:6250	Dep. NTIS, $7.60
6010	1:5322	Dep. NTIS, $4.00
6031-MS	1:4989	Dep. NTIS, $5.45
6040-PR	1:4608	Dep. NTIS, $4.00
6041-T	1:6000	Dep. NTIS, $5.45
6043-MS	1:5487	Dep. NTIS, $4.00
6045-SR	1:4609	Dep. NTIS, $4.00
6054PR	1:5009	Dep. NTIS, $5.45
6057-PR	1:5522	Dep. NTIS, $4.00
6062-MS	1:4916	Dep. NTIS, $4.00
6063	1:6213	Dep. NTIS, $4.00
6075-PR	1:5715	Dep. NTIS, $4.00
6081-PR	1:5262	Dep. NTIS, $5.00
6083-T	1:4568	Dep. NTIS, $5.45
6088-PR	1:5774	Dep. NTIS, $4.00
6095-MS	1:4942	Dep. NTIS, $4.00
6107-MS	1:5056	Dep. NTIS, $4.00
6112-MS	1:4869	Dep. NTIS, $4.50
6115-MS	1:4878	Dep. NTIS, $4.00
6116-MS	1:6017	Dep. NTIS, $4.00
6117-PR	1:5432	Dep. NTIS, $4.00
6125-PR	1:5830	Dep. NTIS, $4.00
6130-MS	1:6150	Dep. NTIS, $4.00
6131—MS	1:6269	Dep. NTIS, $4.00
6138-MS	1:6270	Dep. NTIS, $4.00
6139-MS	1:5057	Dep. NTIS, $4.00
6143-MS	1:4839	Dep. NTIS, $7.60
6145-MS	1:5989	Dep. NTIS, $4.00
LA-tr-		
75-27	1:6095	Dep. NTIS, $4.00
75-31	1:5070	Dep. NTIS, $4.50
75-32	1:5489	Dep. NTIS, $4.50
75-34	1:6301	Dep. NTIS, $5.50
LA-UR-		
75-735	1:5833	Dep. NTIS, $4.50
75-857	1:6112	Dep. NTIS, $4.00
75-1344	1:6123	Dep. NTIS, $6.00
75-1416	1:6001	Dep. NTIS, $4.00
75-1447	1:5996	Dep. NTIS, $4.00
75-1491	1:6124	Dep. NTIS, $4.00
75-1519	1:6125	Dep. NTIS, $4.00
75-1610	1:5815	Dep. NTIS, $4.75
75-1630	1:5834	Dep. NTIS, $4.00
75-1653	1:6271	Dep. NTIS, $4.50
75-1747	1:6045	Dep. NTIS, $4.50
75-1769	1:5835	Dep. NTIS, $4.00
75-1832	1:5440	Dep. NTIS, $4.00
75-1887	1:5816	Dep. NTIS, $4.50
75-1905	1:5811	Dep. NTIS, $4.50
75-1986	1:5710	Dep. NTIS, $5.00
75-1990	1:6272	Dep. NTIS, $4..50
75-2013	1:6273	Dep. NTIS, $4.50
75-2037	1:4622	Dep. NTIS, $5.00
75-2050	1:5968	Dep. NTIS, $4.50
75-2128	1:6196	Dep. NTIS, $4.50
75-2129	1:6197	Dep. NTIS, $4.50
75-2136	1:5628	Dep. NTIS, $4.50
75-2153	1:6163	Dep. NTIS, $4.50
75-2154	1:6198	Dep. NTIS, $4.50
75-2158	1:6199	Dep. NTIS, $4.50
75-2183	1:6200	Dep. NTIS, $4.50
LBL-		
2730	1:5212	Dep. NTIS, $15.00
3040	1:5739	Dep. NTIS, $4.00
3122	1:5365	Dep. NTIS, $5.00
3268	1:4868	Dep. NTIS, $4.50
3275	1:5829	Dep. NTIS, $4.75
3280	1:5846	Dep. NTIS, $4.00
3294	1:5341	Dep. NTIS, $4.50
3798	1:5879	Dep. NTIS, $7.00
3913	1:5378	Dep. NTIS, $7.00
3929	1:5342	Dep. NTIS, $4.50
3930	1:5523	Dep. NTIS, $5.00
3955	1:5343	Dep. NTIS, $7.75
3975	1:5323	Dep. NTIS, $4.50
3985	1:4695	Dep. NTIS, $5.50
4000	1:5984	Dep. NTIS, $10.60
4029	1:6016	Dep. NTIS, $6.50
4056	1:5180	Dep. NTIS, $6.50
4067	1:6020	Dep. NTIS, $12.25
4180	1:6103	Dep. NTIS, $4.50
4212	1:6058	Dep. NTIS, $4.25
4219	1:5524	Dep. NTIS, $4.00
4233	1:6274	Dep. NTIS, $4.00
4237	1:5937	Dep. NTIS, $4.75
4248	1:5514	Dep. NTIS, $4.00
4257	1:6310	Dep. NTIS, $10.00
4258	1:5860	Dep. NTIS, $4.50
4289	1:5904	Dep. NTIS, $4.50
4296	1:6059	Dep. NTIS, $4.50
4299	1:5927	Dep. NTIS, $4.50
4311	1:5905	Dep. NTIS, $5.00
4317	1:6070	Dep. NTIS, $4.00
4408	1:5087	Dep. NTIS, $5.00
4412	1:5693	Dep. NTIS, $5.50
4415	1:4882	Dep. NTIS, $8.50
4420	1:4884	Dep. NTIS, $4.50
4505	1:5277	Dep. NTIS, $5.50
4616	1:5716	Dep. NTIS, $6.75
4621	1:5694	Dep. NTIS, $6.00
4708	1:5802	Dep. NTIS, $4.00
LMEC-		
75-1	1:4943	AT
LMSC-HREC-TR-D-		
390846	1:4813	*See* PB-244174
LTSS-		
304(Ed.1)(Rev.4)	1:6275	Dep. NTIS, $6.00
LYCEN-		
75-05	1:5141	INIS
MATT-		
1140	1:6113	Dep. NTIS, $4.00
1150	1:6126	Dep. NTIS, $4.00
1153	1:6151	Dep. NTIS, $4.00
1160	1:6152	Dep. NTIS, $4.00
1166	1:6188	Dep. NTIS, $4.50
1167	1:6153	Dep. NTIS, $4.00
1169	1:6154	Dep. NTIS, $4.00
1170	1:6164	Dep. NTIS, $4.00
1174	1:6133	Dep. NTIS, $4.00
MHSMP-		
75-24J	1:5547	Dep. NTIS, $4.50
75-24K	1:5314	Dep. NTIS, $4.50
75-29	1:5548	Dep. NTIS, $4.00
75-38	1:5403	Dep. NTIS, $5.50
75-40C	1:5549	Dep. NTIS, $3.50
75-40D	1:5550	Dep. NTIS, $3.50
75-40E	1:5551	Dep. NTIS, $3.50
75-40F	1:5552	Dep. NTIS, $4.00
75-40G	1:5553	Dep. NTIS, $3.50
75-40P	1:5554	Dep. NTIS, $3.50
75-40R	1:5555	Dep. NTIS, $3.50
75-40S	1:5556	Dep. NTIS, $3.50
75-52	1:5557	Dep. NTIS, $4.00
75-54A	1:5558	Dep. NTIS, $3.50
75-54B	1:5559	Dep. NTIS, $4.00
MITNE-		
131	1:4929	*See* COO-2250-2
176	1:4967	*See* COO-2262-8
MLM-		
2270	1:4591	Dep. NTIS, $4.00
MRR-		
145	1:4969	
MTR-		
2951	1:4807	*See* PB-239941
N-		
75-12329	1:4840	NTIS, $3.25
75-14577	1:5847	NTIS, $3.25
75-15585	1:4696	NTIS, $3.25
75-16080	1:4671	NTIS, $3.25
30121	1:4841	NTIS, $3.00
NASA-CR-		
120483	1:4697	NTIS
140384	1:5847	*See* N-75-14577
140842	1:4698	NTIS
140843	1:4699	NTIS

Report No.	Abstract No.	Availibility
NASA-TM-X-		
3136	1:4840	*See* N-75-12329
3189	1:4696	*See* N-75-15585
71596	1:4841	*See* N-30121
71662	1:4671	*See* N-75-16080
NBSIR-		
75-712	1:4798	*See* COM-75-11070
NCSR-R-		
1	1:6251	Dep. NTIS (US Sales Only), $4.50
NMI-		
7020-2	1:5164	Dep. NTIS, $5.50
NOAA-		
75062602	1:4681	*See* COM-75-10983
NP-		
20733	1:5469	Dep. NTIS (US Sales Only), $5.00
NSF-		
74-41	1:4803	GPO, $0.70
NSF/RA/N-		
74-019	1:4805	*See* PB-239397
74-064	1:4806	*See* PB-239516
74-073	1:4717	*See* PB-242529
74-096	1:4808	*See* PB-240610
74-112	1:4665	NTIS
74-119	1:4815	*See* PB-245008
74-185	1:4794	*See* PB-244786
74-196	1:4745	*See* PB-243835
74-197	1:4746	*See* PB-243836
74-198	1:4747	*See* PB-243837
74-205A	1:4686	*See* PB-242898
74-205B	1:4673	*See* PB-242899
74-205C	1:4674	*See* PB-242900
74-205D	1:4687	*See* PB-242901
74-205E	1:4682	*See* PB-242902
75-013	1:4716	*See* PB-241007
75-019	1:4849	*See* PB-243908
75-030	1:4793	*See* PB-242248
75-031	1:4792	*See* PB-242152
75-039	1:4743	*See* PB-243129
75/039C	1:4744	*See* PB-243752
75-048	1:4718	*See* PB-243810
75/059	1:4813	*See* PB-244174
75-060	1:4850	*See* PB-245019
75-075	1:4814	*See* PB-244872
75-081	1:4851	*See* PB-245188
NSF/RANN/SE/GI-		
34871/PR/75/2	1:4750	Dep. NTIS, $7.75
39114/PR/75/1	1:4790	Dep. NTIS, $8.50
39114/TR/75/1	1:4791	Dep. NTIS, $5.50
NTIS/PS-		
75/477	1:4700	NTIS, $25.00
75/691	1:4685	NTIS, $25.00
75/692	1:4701	NTIS, $25.00
75/693	1:4702	NTIS, $25.00
NUREG-		
75/090	1:5010	NTIS, $3.75
NUREG/PRDI-		
75/10	1:4957	TIC
75/11	1:4958	TIC, $1.85
NVO-		
155(Vol2.)	1:5567	Dep. NTIS, $10.60
ORNL-		
5021	1:4970	Dep. NTIS, $7.60
5049	1:4494	Dep. NTIS, $5.45
5060	1:4606	Dep. NTIS, $4.00
5070	1:4971	Dep. NTIS, $4.00
5077	1:6189	Dep. NTIS, $4.00
5080	1:5213	Dep. NTIS, $4.00
5088	1:5165	Dep. NTIS, $5.45
ORNL-NSF-EATC-		
15	1:5315	Dep. NTIS, $5.00
ORNL-TM-		
960	1:5127	Dep. NTIS, $5.50
1000	1:5128	Dep. NTIS, $6.00
1200	1:4570	Dep. NTIS, $6.00
4416	1:4896	Dep. NTIS, $4.00
4660	1:5990	Dep. NTIS, $5.45
4710	1:5407	AT
4777	1:6210	Dep. NTIS, $16.25
4820	1:6165	Dep. NTIS, $5.45
4908	1:4618	Dep. NTIS, $5.45
4999	1:6190	Dep. NTIS, $5.45
5009	1:4990	Dep. NTIS, $4.00
5011	1:4918	Dep. NTIS, $5.45
5020	1:5991	Dep. NTIS, $5.45
5022	1:6127	Dep. NTIS, $4.00
5029	1:5129	AT
5036	1:6176	Dep. NTIS, $5.00
5052	1:5288	Dep. NTIS, $4.00
5055	1:4991	Dep. NTIS, $5.00
5062	1:5013	Dep. NTIS, $4.00
5065	1:6276	Dep. NTIS, $5.45
5070	1:5083	Dep. NTIS, $5.00
5072	1:5992	Dep. NTIS, $4.00
5079	1:6277	Dep. NTIS, $4.00
5081	1:6014	Dep. NTIS, $5.45
5085	1:5014	Dep. NTIS, $4.00
5093	1:4944	AT
5100	1:5289	Dep. NTIS, $4.00
5102	1:5792	Dep. NTIS, $4.00
5110	1:5166	AT
5118	1:5513	Dep. NTIS, $4.00
5120	1:5015	Dep. NTIS, $4.00
5123	1:4580	Dep. NTIS, $5.45
5128	1:5016	Dep. NTIS, $4.00
5131	1:5017	Dep. NTIS, $4.00
5134	1:5831	Dep. NTIS, $4.00
5137	1:6191	Dep. NTIS, $4.00
5163	1:5142	AT
5177	1:6278	Dep. NTIS, $7.75
5182	1:6311	Dep. NTIS, $5.45
5186	1:4523	Dep. NTIS, $4.50
ORNL-tr-		
2973	1:5671	Dep. NTIS, $4.50
4019(Draft)	1:5994	Dep. NTIS, $4.50
4020	1:5993	Dep. NTIS, $4.50
4035	1:5507	Dep. NTIS, $4.50
4036	1:5337	Dep. NTIS, $4.50
4039(Draft)	1:5398	Dep. NTIS, $4.50
4040	1:6046	Dep. NTIS, $4.50
4041	1:4964	Dep. NTIS, $4.50
4045	1:5629	Dep. NTIS, $4.50
4056	1:5633	Dep. NTIS, $4.50
4060	1:5478	Dep. NTIS, $4.50
ORO-		
240	1:6100	Dep. NTIS, $5.00
3329-11	1:5764	Dep. NTIS, $4.50
3781-12	1:5381	Dep. NTIS, $4.50
3898-27	1:5389	Dep. NTIS, $4.50
3941-24	1:5786	Dep. NTIS, $4.00
3980-20	1:5696	Dep. NTIS, $4.50
3992-227	1:5971	Dep. NTIS, $4.00
3992-234	1:5958	Dep. NTIS, $4.25
3992-235	1:5949	Dep. NTIS, $5.00
3992-236	1:5944	Dep. NTIS, $4.50
3992-237	1:5950	Dep. NTIS, $5.50
4856-21	1:6099	Dep. NTIS, $4.50
4856-22	1:6053	Dep. NTIS, $5.50
4856-36	1:6054	Dep. NTIS, $4.50
OWRT-A-		
015-WYO(1)	1:4672	*See* PB-241514
080-MO(1)	1:4684	*See* PB-239402
PATENTS-US-		
A510,677	1:4721	
A533,048	1:5335	
A541,177	1:5477	
A548,941	1:5336	
3,782,455	1:5416	
3,892,529	1:5773	
3,894,086	1:5564	
3,894,476	1:5419	
3,895,243	1:5078	
3,895,674	1:5420	
3,895,810	1:5421	
3,896,501	1:5422	
3,896,873	1:5423	
3,897,659	1:5424	
3,898,101	1:5034	
3,898,101	1:5035	
3,898,172	1:5536	
3,899,296	1:5537	
3,900,034	1:5768	
3,901,658	1:5538	
3,902,695	1:5425	
3,906,081	1:4562	
3,906,858	1:5565	
3,907,513	1:5264	
3,907,589	1:5038	
3,908,124	1:5539	

Report No.	Abstract No.	Availibility
3,908,278	1:5426	
3,908,380	1:4873	
3,908,762	1:4552	
3,909,713	1:5540	
3,910,834	1:4557	
3,913,671	1:4553	
3,913,672	1:4554	
3,915,234	1:4555	
3,915,498	1:4556	
PB-		
234565	1:4704	NTIS, $4.00
235347	1:4705	NTIS, $3.75
235481	1:4706	NTIS, $3.25
236189	1:4707	NTIS, $4.75
236193	1:4708	NTIS, $4.75
236196	1:4842	NTIS, $5.75
236208	1:4843	NTIS, $3.75
238003	1:4844	NTIS, $3.75
238073	1:4830	NTIS, $9.25
238109	1:4831	NTIS, $3.75
238161	1:4667	NTIS, $7.00
238506	1:4733	NTIS, $4.25
238545	1:4731	NTIS, $3.25
238947	1:4709	NTIS, $3.75
239184	1:4710	NTIS, $3.75
239270	1:4711	NTIS, $11.25
239277	1:4736	NTIS, $5.75
239280	1:4712	NTIS, $3.75
239282	1:4713	NTIS, $3.75
239355	1:4804	NTIS, $5.75
239372	1:4714	NTIS, $3.75
239397	1:4805	NTIS, $4.75
239402	1:4684	NTIS, $4.25
239516	1:4806	NTIS, $7.25
239758	1:4845	NTIS, $5.75
239941	1:4807	NTIS, $4.25
240610	1:4808	NTIS, $5.25
240611	1:4809	NTIS, $8.50
240910	1:4715	NTIS, $3.75
241006	1:4846	NTIS, $4.25
241007	1:4716	NTIS, $6.25
241089	1:4847	NTIS, $7.00
241090	1:4848	NTIS, $5.25
241117	1:4810	NTIS, $3.75
241514	1:4672	NTIS, $4.75
242152	1:4792	NTIS, $5.25
242248	1:4793	NTIS, $4.25
242529	1:4717	NTIS, $4.25
242898	1:4686	NTIS, $7.25
242899	1:4673	NTIS, $7.00
242900	1:4674	NTIS, $7.25
242901	1:4687	NTIS, $9.50
242902	1:4682	NTIS, $5.75
243129	1:4743	NTIS, $3.75
243455	1:4811	NTIS, $7.60
243498	1:4812	NTIS, $10.00
243635	1:4675	NTIS, $3.75
243752	1:4744	NTIS, $6.25
243810	1:4718	NTIS, $4.25
243835	1:4745	NTIS, $3.75
243836	1:4746	NTIS, $7.50
243837	1:4747	NTIS, $15.25
243908	1:4849	NTIS, $12.00
244174	1:4813	NTIS, $3.75
244786	1:4794	NTIS, $4.25
244872	1:4814	NTIS, $4.25
245008	1:4815	NTIS, $4.75
245019	1:4850	NTIS, $5.25
245188	1:4851	NTIS, $3.75
245669	1:4816	NTIS, $5.25
PEM-		
37	1:5517	Dep. NTIS, $4.50
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45	1:5470	Dep. NTIS, $4.50
PERC-		
0009-1	1:4499	Dep. NTIS, $4.50
PERC/RI-		
75/5	1:4528	Dep. NTIS, $4.00
PNE-RB-		
70	1:4549	Dep. NTIS, $7.00
71	1:5568	Dep. NTIS, $5.50
PRNC-		
185	1:4978	Dep. NTIS, $12.75
188	1:5686	Dep. NTIS, $6.00

Report No.	Abstract No.	Availibility
PU-		
75-425	1:5965	*See* COO-1428-429
RDT-F-		
3-6T(10-75)	1:4972	RSO
11-3T(9-75)	1:5316	RSO
RDT-INDEX-		
(7-75)	1:4959	RSO
10(75)	1:4960	RSO
RDT-M-		
4-1T(8-75)	1:5134	RSO
REG/G-		
1.79(Rev.1)(9-75)	1:4965	NUREG
RFP-		
2233	1:5143	Dep. NTIS, $4.00
RFP-Trans-		
169	1:5366	Dep. NTIS, $4.50
RISO-		
302	1:5130	Dep. NTIS (US Sales Only), $6.50
RISO-M-		
1808	1:5612	Dep. NTIS (US Sales Only), $6.50
1828	1:6279	Dep. NTIS (US Sales Only), $3.50
RLO-		
1388-290	1:6009	Dep. NTIS, $4.50
1388-291	1:6010	Dep. NTIS, $5.00
1388-293	1:6005	Dep. NTIS, $4.50
1388-295	1:6006	Dep. NTIS, $4.50
2225-32	1:6246	Dep. NTIS, $4.50
SAAS-		
178	1:5793	Dep. NTIS (US Sales Only), $5.00
SAI-		
75-636-LJ	1:6141	Dep. NTIS, $22.75
SAND-		
74-8221	1:6280	Dep. NTIS, $7.60
75-0116	1:5525	Dep. NTIS, $4.00
75-0130	1:5241	Dep. NTIS, $4.00
75-0223	1:4945	Dep. NTIS, $4.00
75-0242	1:6312	Dep. NTIS, $4.00
75-0285	1:5471	Dep. NTIS, $5.45
75-0344	1:4558	Dep. NTIS, $4.00
75-0362	1:5167	Dep. NTIS, $5.45
75-0431	1:4887	Dep. NTIS, $5.00
75-0443	1:5895	Dep. NTIS, $6.00
75-0455	1:5854	Dep. NTIS, $4.00
75-0483	1:5290	Dep. NTIS, $4.00
75-0492	1:5441	Dep. NTIS, $4.00
75-0500	1:5560	Dep. NTIS, $4.50
75-0513	1:5344	Dep. NTIS, $4.00
75-0518	1:5668	Dep. NTIS, $4.00
75-0542	1:4817	Dep. NTIS, $5.50
75-0543	1:5408	Dep. NTIS, $3.50
75-0616	1:5472	Dep. NTIS, $4.00
75-5225	1:5561	Dep. NTIS, $5.00
75-5351	1:4610	Dep. NTIS, $4.50
75-5362	1:5409	Dep. NTIS, $4.25
75-5386	1:5233	Dep. NTIS, $4.00
75-5390	1:5269	Dep. NTIS, $4.50
75-5444	1:5243	Dep. NTIS, $4.00
75-5462	1:5526	Dep. NTIS, $4.50
75-5472	1:5324	Dep. NTIS, $4.00
75-5478	1:5460	Dep. NTIS, $4.25
75-5492	1:4863	Dep. NTIS, $4.25
75-5601	1:4594	Dep. NTIS, $4.00
75-5615	1:5234	Dep. NTIS, $4.50
75-5629	1:5442	Dep. NTIS, $4.50
75-5640	1:5788	Dep. NTIS, $4.25
75-5643	1:5410	Dep. NTIS, $4.50
75-5658	1:5439	Dep. NTIS, $4.50
75-5666	1:6214	Dep. NTIS, $4.50
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75-5730	1:4719	Dep. NTIS, $4.50
75-5744	1:5411	Dep. NTIS, $4.00
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75-5747	1:6134	Dep. NTIS, $4.50
75-5752	1:6084	Dep. NTIS, $4.50
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75-5884	1:6211	Dep. NTIS, $4.50
75-5993	1:5412	Dep. NTIS, $4.50
75-5995	1:5131	Dep. NTIS, $4.50
75-6063	1:5473	Dep. NTIS, $4.50
75-6160	1:4864	Dep. NTIS, $4.50
75-7081	1:5474	Dep. NTIS, $4.50

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75-8047	1:5595	Dep. NTIS, $4.00
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75-8640	1:5304	Dep. NTIS, $5.00
75-8679	1:6236	Dep. NTIS, $4.50
SC-DC-		
68-2288	1:5433	Dep. NTIS, $4.50
SC-PR-		
67-837	1:4619	Dep. NTIS, $5.50
69-20	1:4620	Dep. NTIS, $5.50
SC-TM-		
71-0257	1:5434	Dep. NTIS, $4.00
SLAC-		
185	1:5906	Dep. NTIS, $7.50
SM-		
6/26	1:5817	*See* BNWL-SA-5456
199/42	1:5647	*See* UCRL-77318
199/52	1:5643	*See* CONF-751105-4
199/87	1:4600	*See* ARH-SA-232
199/100	1:4622	*See* LA-UR-75-2037
199/114	1:5807	*See* BNWL-SA-5588
202/303	1:5809	*See* BNL-20599
202/416	1:5810	*See* CONF-751126-6
202/524	1:5799	*See* CONF-751126-1
SR-		
6/28	1:5818	*See* BNWL-SA-5464
SRO-		
825-1	1:5669	Dep. NTIS, $4.50
854-4	1:5376	Dep. NTIS, $4.50
STAN-CS-		
75-481	1:6286	*See* SU-326-PA30-39
STI/PUB-		
382	1:5826	IAEA, $31.00
SU-		
326-P30-42	1:6283	Dep. NTIS, $5.50
326P-39-2	1:6287	*See* SU-SEL-75-037
326-P39-5	1:6284	Dep. NTIS, $3.50
326P39X3	1:6285	Dep. NTIS, $4.50
326-PA30-39	1:6286	Dep. NTIS, $5.00
SU-SEL-		
75-037	1:6287	Dep. NTIS, $5.50
TE-		
4166-6-74	1:4730	*See* TEE-3056-2
5392-34-75	1:4831	*See* PB-238109
TEE-		
3056-2	1:4730	Dep. NTIS, $10.75
TID-		
24922	1:5073	Dep. NTIS, $11.00
26736	1:5527	Dep. NTIS, $4.00
26811(P4)	1:4961	GPO, $14.70
26811(P7)	1:4962	GPO, $16.85
26811(P8)	1:4963	GPO, $15.95
26871	1:4720	Dep. NTIS, $4.50
26872	1:5645	Dep. NTIS, $11.50
26878	1:6142	Dep. NTIS, $19.00
26884	1:5678	Dep. NTIS, $4.75
26886	1:6288	Dep. NTIS, $6.75
26888	1:4737	Dep. NTIS, $5.50
26900	1:5039	Dep. NTIS, $5.00
26907	1:4678	Dep. NTIS, $4.50
26910	1:6114	Dep. NTIS, $5.00
26912	1:5654	Dep. NTIS, $7.00
TT-		
74-54003/4	1:5382	*See* AEC-tr-7533/4
UCCND-CSD-		
15	1:6289	Dep. NTIS, $4.00
UCCND-CSD-INF-		
72	1:6290	Dep. NTIS, $6.50
UCI-		
34P149X4	1:5916	Dep. NTIS, $5.50
UCID-		
16865	1:6074	Dep. NTIS, $4.75
16877	1:4852	Dep. NTIS, $4.00
16890	1:5855	Dep. NTIS, $4.00
16894	1:5579	Dep. NTIS, $5.50
16901	1:6107	Dep. NTIS, $4.00
16910(Pt.1)	1:5580	Dep. NTIS, $5.45
16916	1:6313	Dep. NTIS, $4.00
16923	1:6291	Dep. NTIS, $4.00
16925	1:5443	Dep. NTIS, $4.00
16926	1:5444	Dep. NTIS, $5.00
16928	1:6292	Dep. NTIS, $4.00
16930	1:5445	Dep. NTIS, $4.00
16932	1:5274	Dep. NTIS, $4.50
16934	1:5291	Dep. NTIS, $4.50
16935	1:5446	Dep. NTIS, $5.00
16937(Pt.1)	1:5528	Dep. NTIS, $4.00
16937(Pt.2)	1:5529	Dep. NTIS, $4.00
16938	1:4559	Dep. NTIS, $5.00
16940	1:6237	Dep. NTIS, $4.00
16941	1:6238	Dep. NTIS, $4.00
16942	1:6239	Dep. NTIS, $4.00
16946	1:5249	Dep. NTIS, $4.50
16950	1:4537	Dep. NTIS, $4.50
16951	1:4865	Dep. NTIS, $4.00
16952	1:5317	Dep. NTIS, $4.00
16954	1:4870	Dep. NTIS, $5.00
16958	1:6038	Dep. NTIS, $4.50
16960	1:5447	Dep. NTIS, $4.00
30040(Ed.7)	1:6293	Dep. NTIS, $5.50
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30120	1:5596	Dep. NTIS, $5.45
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12-1019	1:5717	Dep. NTIS, $3.50
34P88-36	1:5861	Dep. NTIS, $4.50
UCLA-ENG-		
7582	1:5018	Nuclear Regulatory Commission, Washington, DC
UCRL-		
6028-T	1:6027	Dep. NTIS, $4.50
13586	1:5305	Dep. NTIS, $6.50
13638	1:4611	Dep. NTIS, $8.50
50002-74	1:6166	Dep. NTIS, $5.45
51803	1:5655	Dep. NTIS, $7.60
51847	1:6104	Dep. NTIS, $4.50
51876	1:4538	Dep. NTIS, $7.60
51892	1:5562	Dep. NTIS, $4.00
51906	1:4992	Dep. NTIS, $4.00
51911	1:5292	Dep. NTIS, $4.00
51912	1:4871	Dep. NTIS, $4.50
51913(Pt.1)	1:5681	Dep. NTIS, $4.00
51916	1:5144	Dep. NTIS, $5.45
51923	1:5113	Dep. NTIS, $4.00
51925	1:6050	Dep. NTIS, $4.00
51929	1:6215	Dep. NTIS, $4.00
51933	1:5413	Dep. NTIS, $4.00
51934	1:5414	Dep. NTIS, $4.00
51944	1:4879	Dep. NTIS, $4.00
51945	1:5325	Dep. NTIS, $4.00
51950	1:5660	Dep. NTIS, $4.00
51956	1:5718	Dep. NTIS, $4.00
52000-75-10	1:5435	Dep. NTIS, $5.00
75899(Rev.1)	1:5334	Dep. NTIS, $5.00
76027	1:6296	Dep. NTIS, $3.50
76341	1:6216	Dep. NTIS, $4.50
76390(Rev.1)	1:4832	Dep. NTIS, $4.50
76889	1:5345	Dep. NTIS
76891	1:5023	Dep. NTIS, $4.50
76936	1:5613	Dep. NTIS, $4.00
76947	1:5836	Dep. NTIS, $5.00
76958	1:5448	Dep. NTIS, $4.50
76967	1:5837	Dep. NTIS, $5.75
76985	1:6167	Dep. NTIS, $5.00
77003	1:6205	Dep. NTIS, $5.00
77024	1:6135	Dep. NTIS, $4.50
77079	1:6115	Dep. NTIS, $4.00
77094(Rev.1)	1:6217	Dep. NTIS, $6.00
77105	1:6206	Dep. NTIS, $4.50
77116(Rev.1)	1:5415	Dep. NTIS, $4.50
77127	1:6218	Dep. NTIS, $4.50
77153	1:6240	Dep. NTIS, $4.50
77215	1:6201	Dep. NTIS, $4.50
77226	1:6241	Dep. NTIS, $4.50
77227	1:6192	Dep. NTIS, $4.50
77230	1:6146	Dep. NTIS, $4.50
77233	1:6168	Dep. NTIS, $4.50
77234	1:6242	Dep. NTIS, $4.50
77235	1:6193	Dep. NTIS, $4.50
77236	1:6243	Dep. NTIS, $4.50
77238	1:6244	Dep. NTIS, $4.50
77239	1:6207	Dep. NTIS, $4.50
77241	1:6194	Dep. NTIS, $4.50
77242	1:6219	Dep. NTIS, $4.50
77243	1:6169	Dep. NTIS, $4.50
77244	1:6195	Dep. NTIS, $4.50
77247	1:6128	Dep. NTIS, $4.50
77248	1:6220	Dep. NTIS, $4.50
77249	1:6221	Dep. NTIS, $4.50
77260	1:6170	Dep. NTIS, $4.50

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77264	1:6171	Dep. NTIS, $4.50
77269	1:6172	Dep. NTIS, $4.50
77290	1:5181	Dep. NTIS, $4.25
77315	1:5670	Dep. NTIS, $4.50
77318	1:5647	Dep. NTIS, $4.50
77345	1:5236	Dep. NTIS, $4.00
77357(Rev.1)	1:6245	Dep. NTIS, $5.00
77395	1:4581	Dep. NTIS, $4.50
77443	1:6297	Dep. NTIS, $4.50
77449	1:5475	Dep. NTIS, $4.50
77454	1:5476	Dep. NTIS, $5.50
77456	1:6208	Dep. NTIS, $5.00
77478	1:6129	Dep. NTIS, $4.50
77480	1:5449	Dep. NTIS, $4.50
77486	1:5024	Dep. NTIS, $3.50
77499	1:6222	Dep. NTIS, $4.50
77504	1:6130	Dep. NTIS, $4.50
77533	1:5719	Dep. NTIS, $-4.50
77543	1:5025	Dep. NTIS, $4.50
77547	1:5293	Dep. NTIS, $4.50
77567	1:5026	Dep. NTIS, $3.50
77568	1:5027	Dep. NTIS, $3.50
77569	1:5028	Dep. NTIS, $3.50
UCRL-Trans-		
1521	1:5367	Dep. NTIS, $4.00
10518	1:5148	Dep. NTIS, $4.50
10727	1:5630	Dep. NTIS, $4.50
10911	1:5214	Dep. NTIS, $4.00
10915	1:6155	Dep. NTIS, $4.50
10916	1:5632	Dep. NTIS, $5.50
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10919	1:4613	Dep. NTIS, $4.50
10934	1:5216	Dep. NTIS, $4.50
10946	1:5450	Dep. NTIS, $5.00
10955	1:4529	Dep. NTIS, $4.50
10971	1:5530	Dep. NTIS, $5.00
10984	1:4524	Dep. NTIS, $4.00
UCSC-		
34P197X4	1:5903	Dep. NTIS, $4.50
UEC-AEC-		
740107(Draft)	1:4979	Dep. NTIS, $11.00
UIUCDCS-APR-		
75	1:6264	*See* COO-2383-0028
UKY-TR-		
74-CME3	1:4495	Univ. of Kentucky, Lexington
UNI-		
351	1:4993	Dep. NTIS, $4.00
UNI-SA-		
18	1:5397	Dep. NTIS, $4.50
19	1:6314	Dep. NTIS, $4.50
UR-		
546	1:5914	*See* COO-3065-124
547	1:5933	*See* COO-3065-125
3490-832	1:5798	*See* CONF-750671-2
USNA-TSPR-		
66	1:4751	*See* AD/A-015-954
WAPD-TM-		
1199	1:4946	Dep. NTIS, $6.00
WARD-MRP-		
144	1:4912	Dep. NTIS, $4.50
WARD-SG-		
3045-1(Vol.2)	1:4947	AT
Y-		
1990	1:4595	Dep. NTIS, $5.45
Y-DA-		
6352	1:5145	Dep. NTIS, $4.50
6354	1:5146	Dep. NTIS, $4.50
Y-OA-		
1550	1:5147	Dep. NTIS, $4.50

Abbreviations Used in Availability Column

AT Liquid Metal Fast Breeder Reactor applied technology is available to domestic requesters within the United States from the USERDA Technical Information Center, P. O. Box 62, Oak Ridge, TN 37830.
Information regarding subscription purchase will be sent on request.
Foreign requesters should address inquiries to the above address.

Dep. ERDA reports so designated are maintained in the organizations listed on the inside front cover.

EM Inquiries regarding the availability of blueline prints of ERDA engineering drawings which were formerly available for sale by NTIS should be addressed to USERDA, Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

GJO Available from USERDA, Grand Junction Office, P. O. Box 2567, Grand Junction, Colorado 81501.

GPO For sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

LMEC Available *only to requesters within the United States* from the Liquid Metal Engineering Center, P. O. Box 1449, Canoga Park, CA 91304.

NTIS For sale by the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161. Price given is the domestic price for paper copy; foreign purchasers add $2.50 per report copy.

RSO Available *only to requesters within the United States* from the Reactor Standards Office, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, TN 37830.

TIC Available from the USERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.